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SCIENCE & TECHNOLOGY
USSR: SCIENCE & TECHNOLOGY POLICY

CONTENTS

FACILITIES, MANPOWER

Personnel Potential of Science Under Intensification
(G. A. Lakhtin; VESTNIK AKADEMII NAUK SSSR, No 3,
Mar 87)..... 1

AUTOMATION, INFORMATION POLICY

Automation, Electronization in Machine Building
(P. N. Belyanin; VESTNIK AKADEMII NAUK SSSR, No 3,
Mar 87)..... 12

REGIONAL ISSUES

Formation, Development of Azerbaijan Scientific Potential
(G. A. Gyandzhiyev; IZVESTIYA AKADEMII NAUK
AZERBAYDZHANSKOY SSR: SERIYA EKONOMIKI, No 1-2, 1986).... 21

Management of Ukrainian S&T Progress on Basis of Automation
(V. Shevchenko; EKONOMIKA SOVETSKOY UKRAINY, No 11,
Nov 86)..... 32

GENERAL

Scientific, Technical Progress in Party Economic Strategy
(M. Chernenko; EKONOMICHESKIYE NAUKI, No 11, Nov 86)..... 44

Product Quality, Scientific, Technical Progress
(N. A. Yevstropov, I. G. Leonov, et al.; STANDARTY I
KACHESTVO, No 2, Feb 87) 57

Product Quality as National Economic Task
(I. G. Leonov, I. V. Matveyeva; STANDARTY I KACHESTVO,
No 1, Jan 87) 67

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FACILITIES AND MANPOWER

UDC 001.89

PERSONNEL POTENTIAL OF SCIENCE UNDER INTENSIFICATION

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 3, Mar 87 pp 33-42

[Article by Doctor of Economic Sciences G.A. Lakhtin under the rubric "The Organization and Efficiency of Scientific Research": "The Personnel Potential of Science Under the Conditions of Intensification"]

[Text] Today science in a certain sense is going through a critical period. One of the manifestations of this change is the subsiding of the growth of the number of researchers, which presumes the replacement of quantitative growth with qualitative growth. Thus, in what directions should qualitative development process--this question is inevitably becoming the key one in all science policy.

The systems approach makes it incumbent to examine each object in two ways: as an element of some system and as an independent system with its own internal arrangement. Strictly speaking, it is possible to distinguish two tasks which science policy is called upon to accomplish: the "external" and the "internal."

The former is to determine the place of science in the overall balance of expenditures and results and the share of national economic resources, which is being allocated to it. The latter is to find the necessary proportions between the components of science itself and to seek such a structure and order of actions, which will ensure the greatest success rate. As applied to the personnel of science these tasks are specified: the former is to determine the optimum share of scientists in the overall personnel balance of the country, particularly among workers of the highest skills; the latter is to find the conditions and stimuli, which ensure the greatest aggregate return and guarantee further scientific progress.

Very nontrivial questions arise here, and the researchers, who are studying scientific activity, are not yet able to answer many of them. But it is necessary already today to be aware of the very existence of these unresolved questions and their nature--if only to understand what the indirect consequences of some practical steps or others might be, what it is possible in principle to achieve by means of them and what it is not, what new problems might arise as a result of some steps or others, and whether these new

problems will be in some way more serious than the ones, for the solution of which these steps are being taken.

In this article we would also like to direct attention to several of these unresolved questions.

The Problem of the Number of Scientists

The majority of authors predict the stabilization of the number of scientists, linking it with the transition of science to the path of intensive development. The inevitability of this transition does not arouse doubts, but it must not be forgotten: intensification is not the reduction of the influx of new resources as such, but the increase of the return from the resources being invested. In science such an increase, in principle, is possible in case of a stable, decreasing, and increasing number of personnel.

In order to understand better the nature of the problems arising here, it is useful to take a look a history.

For a long time quantitative growth was the basic form of the development of scientists in our country as a whole, just as throughout the world. If, as is usually done, we examine the increase of the number of scientists (thousands of people),⁽¹⁾ we will observe a comparatively stationary progressive process:

1931	57.8	1950	162.5	1970	927.4
1934	65.5	1960	354.2	1975	1223.4
1940	98.3	1965	664.6	1980	1373.3

However, we will not forget that people, who are engaged in principle in different types of activity: researchers proper, who work at scientific institutions, and instructors of higher educational institutions, are included in this accounting category. If from the total number of scientists we single out those who are employed at scientific research institutes and their affiliates, we will get a completely different picture: the increase of the number of researchers was markedly irregular. Periods of the rapid increase of the number alternated with periods of the subsiding of the pace.

The first upswing falls to 1918-1920. The young Soviet government made it possible to solve a number of urgent problems, which were identified by science itself, and, despite all the difficulties connected with the civil war and dislocation, established a significant number of scientific research institutions for those times. Unfortunately, quantitative data on the number of researchers during that period are lacking (the first reference book appeared in 1920); it is possible to judge the occurring upswing from the number of established scientific organizations: during 1918-1920 more than 40 new scientific research institutes were organized in the country, their total number at the end of 1922 came to 70.⁽²⁾ At the beginning of the New Economic Policy (1921) the growth in question slowed. As V.I. Lenin said, the republic was forced to economize "even on schools."⁽³⁾

The period of especially rapid, "explosive" growth of the amounts of scientific research activity falls to 1929-1933. During those years the

Academy of Sciences, which became as a result of the reforms of 1926-1930 the leading scientific institution of the country, gained strength, sectorial science was formed as a branched scientific system with the most personnel. The number of researchers for the indicated years increased by more than twofold, in individual years the increase came to 60 percent. But in 1934 a decline began--a decrease of the number of personnel of scientific research institutions, which continued until the war itself (from 48,000 to 37,000). The total number of scientists continued to increase steadily at an average rate of about 11 percent a year. If we did not differentiate the two basic categories--instructors and researchers, the most important critical feature would remain unnoticed: the decrease of the number of researchers in the total increase of the number of scientists signified that at the boundary between 1933 and 1934 priority was given to higher education--the training of skilled personnel for the national economy in conformity with the maxim "personnel decide everything." Soon the number of professors and instructors surpassed the number of researchers.

During the period of the war and the postwar restoration (1941-1953) the average annual growth rate of the number of scientists decreased as compared with the prewar period and came to 5.2 percent. But it is characteristic that the number of scientists at research institutions increased more rapidly than at higher educational institutions.

Then a period of a new upswing of research activity and, accordingly, the sharp increase of the number of researchers began (1954-1962). The total number of scientists increased at approximately the prewar rate (on the average 11.8 percent a year), but within it the number of researchers increased significantly more rapidly (up to 25 percent a year). In 1958 the number of researchers again surpassed the number of instructors. An especially rapid upswing falls to the years, when the management of industry was carried out the councils of the national economy, which had the right to establish new institutions and actually did establish many of "their own" units, although small ones. Again the dialectics of development brought the need for research results in contact with the needs of other spheres of activity (first of all physical production and higher education) for specialists. And again, as in the 1930's, centralized intervention was required in order to halt the inadequately controlled growth. In 1962 state sectorial committees, which took applied science in their hands, were organized. After this a period of stabilized growth (1963-1975) at a rate on the order of 7-8 percent a year began.

At the boundary between 1975 and 1976 the growth rate decreased drastically (1976--2.5 percent, 1977--2.1 percent, 1978--2.1 percent, and so on). The commenced stage is characterized by the freezing and even the decrease of the staff of a large number of scientific research institutions. Recent years are not an exception. The total number of personnel, although increasing, is increasing far from how it did previously.

	Scientists, thousands	People employed in science and scientific service, thousands
1980	1373.3	4379
1981	1411.2	4477
1982	1431.7	4475
1983	1440.0	4471

What are the causes of the irregularity, the abrupt nature of the increase of the number of researchers? It seems that each observed jump was the resolution of a contradiction between the nature of the system of scientific institutions, which had formed by that time, and the needs of social production. It is a question not of a quantitative discrepancy, which could have been eliminated by the simple addition of staff, but of a qualitative contradiction, which required new organizational forms and found a solution in the establishment of new scientific institutions and the filling up of their staffs by the influx of young people.

During the first postrevolution years the Soviet republic established not simply individual scientific organizations, the need for which had become urgent long ago and was realized--the very system of professional research activity, which was placed at the service of socialism, was established. A new type of institution of science--the specialized scientific research institute--emerged as the primary unit of this system.

The second jump falls to the period of launched industrialization. Entire new sectors (the automotive, aviation, and bearing industries and others) were established, while traditional ones (metallurgy, light industry) were modernized on a new technical basis which was advanced for that time. The sectors required the solution of a large number of technical problems, but the scientific system that existed (the institutes of the Academy of Sciences and the problem institutes which had been established in previous years) was not ready for this. A new scientific system, which was closely connected with production and was formed in accordance with the sectorial principle, with subordination to the same organs as enterprises (the People's Commissariats), was required.

The national economic upswing of the mid-1950's was of a qualitatively different nature than during the years of the first five-year plans. It was necessary not only to establish new enterprises and sectors, but also to use more intensively the already available enormous industrial potential. The unification of scientific progress and technical development into a single flow--scientific and technical progress--became urgent. The July (1955) CPSU Central Committee Plenum adopted in essence the first program of scientific and technical progress (although such a term did not yet exist). The regional development of productive forces assumed a significant scale, which required the establishment of integrated regional institutes and scientific centers. The establishment of academies of sciences in the union republics was completed, the establishment of the largest scientific center in Siberia was begun. All these factors gave rise to a jump, which is recorded by statistics as a temporary sharp increase of the growth rate of the number of researchers.

The now existing situation also has contradictions, which it is hardly possible to eliminate by the efforts of existing institutes. The sectorial structure of the network of applied scientific organizations, which at one time was progressive, is ceasing to conform to the intersectorial nature of modern scientific and technical problems. In the management of scientific and technical progress the goal program principle is becoming firmly established, there are no organizations "under the program."

Another imminent contradiction is between the actual role of sectorial institutes (not to mention the plant sector of science), which by inertia are oriented toward "scientific service," and the necessary role of the leaders of scientific and technical progress. It is a question not only of the break with minor themes which are dictated by the immediate needs of production. The demands on science, which found concentrated expression in the materials of the 27th CPSU Congress, can be realized by scientific institutions, which are oriented entirely toward the development of equipment of new generations, equipment which will be advanced at the moment of introduction. Such an orientation may also require more perfect organizational forms.

It is possible to add to this that in science collectives of like-minded people, which formed naturally around a recognized leader, are most fruitful. These should be comparatively small organizations, in which the manager combines formal management and informal leadership. Formal management should give him the rights and staff and financial means to attract staff members, who share a common approach and common scientific interests. To some extent the scientific research institutes, which were established during the first years of Soviet power, can serve here as an analogy: the number of their scientific personnel came to 25-30, they were formed "for a problem" (for example, the Radium Institute) and were managed by leading scientists.

The necessity of a breakthrough into new scientific fields can require the establishment of such collectives, but they will yield a real result, if their are established not only by the reshuffling of existing personnel, but also by selection "from zero," for which free staff are needed.

On the other hand, it has to be noted that science proved to be unprepared for the transition to completely intensive development under the conditions of the stabilization of the numerical composition. The freezing of the number of personnel of scientific institutions in the absence of compensatory steps is accompanied by such phenomena as the aging of scientific collectives, stagnation and the loss of stimuli, the decrease of occupational mobility, and unnecessary thematic continuity.

The aging of collectives, of which the participants in the latest session of the General Assembly of the USSR Academy of Sciences complained,(4) is an inevitable phenomenon in case of an inadequate influx of young reinforcements. We do not have systematic statistics which would characterize the changes of the age structure of scientists, that is, the data that are available testify to an increase of the proportion of older ages, particularly among doctors and candidates of sciences. And what we are now observing is only the first signals of aging. But it is a matter even not of the changes themselves in the age composition, but of the phenomena connected with them. A high

official level, which gives the right to make decisions, including on the choice of themes, on the evaluation of new ideas and inventions, on the organization of work in new directions, and so on, also comes with the years. With the acceleration of the change of dominant concepts a negative attitude toward innovations, which is frequent among middle-aged scientists, can have a more and more appreciable effect, doing definite harm to scientific and technical progress.(5)

The freezing of the number of scientific personnel under present conditions also decreases the possibilities of job advancement, which is one of the most important stimuli. A stratum of scientists, whom it is already impossible to call young, is accumulating at institutes: they have to their credit completely independent scientific works and also very unclear job prospects. Under the conditions of the stabilization of the size and, accordingly, the organizational structure of institutions opportunities of job advancement for them emerge only with the natural vacating of superior positions. The harm from the reduction of creative efforts as a consequence of the loss of stimuli, of course, defies calculation, but it is hardly possible to doubt that it exists. If it does increase, it will perhaps be socially more advantageous to create a safety valve in the form of the increase of the number of staff.

The stabilization of the number is also conducive to the strengthening of thematic continuity. The long-term (if not life-long) connection of a worker of science with one theme is understood by this. It can be renamed in connection with formal completion and continuation under the new name and can be expanded, additionally encompassing new objects, but the basic direction is the former direction. Thematic mobility, which is associated with the change of not only the objects or methods of research, but also the areas of scientific work and even specialization, appears as the opposite characteristic. Excessive thematic stability can have the result that performers will not be found for fundamentally new themes which lead to revolutionary changes in equipment. It is possible to offset thematic stability under the conditions of the acceleration of scientific and technical progress only by the replacement of personnel.

Such are several conclusions which make it possible to assume as possible a new increase of the number of personnel of science, although not as sharp a one as the previous ones were. Nevertheless an abrupt nature should be characteristic of it, first, because it will serve as a discharge of contradictions, which have been accumulating for a long time, and, second, because it will be accompanied by the appearance and development of fundamentally new organizational forms--otherwise the addition of staff will be dissolved in the formed organizational structures and already developed thematic directions.

Problems of the Qualitative Improvement of Personnel

Of course, not quantitative growth, but qualitative development will be the chief, main line in the personnel policy of science under all conditions. Since the basic problems of personnel policy are connected with the necessity of the acceleration of scientific and technical progress, here first of all

Thus, scientific and technical progress requires the development of a mechanism that makes it possible first, to identify capable people, second, to direct them to the sphere of science, and, third, to keep them there.

The first step is the identification of gifted people. Diagnosis appears as the basic problem: How is one to single out by objective criteria from the mass of young people, who have received an education, the few capable ones? In the literature there is no lack of lists of innate qualities which a scientist needs. All of them do not coincide and are frequently at variance with each other. Obviously, the compiling of such lists is an unreliable job: there is hardly any intellectual merit that would be undesirable in a scientist. Especially as a set of all possible qualities is incorporated in any person, but they can be present to a different degree. The matter is complicated even more by the difference of roles in the research collective: theorists, organizers, generators of ideas, experimenters, "deliverers," and others; once again the most contradictory opinions exist with respect to the composition of these roles. Apparently, one should, without waiting until social psychology and the psychology of creativity give answers to numerous questions, take as a basis a universally recognized fact: there is a generalized quality--the capacity for scientific research work, the ability to yield a scientific result, the innate talent of a researcher, and with respect to this quality the people in science are markedly unequal. While only scientific research work acts for the present as the only means of identifying this quality. Consequently, it should be started as early as possible--before the start of professional work in science, during the student years, and not as an optional load, but in earnest. And its role should be revised--it should be regarded as a mandatory test. It is much easier not to allow unfit people into science than to get rid of them later. But here we come up against an unresolved question: Should specialists be trained at higher educational institutions separately for science and production or should they be given a uniform higher education?

The second step is vocational guidance. Suppose that we have found a method of identifying without error talented young people; it is still necessary to see to it that they want to enter science.

Moreover, the training and monitoring of the work of the selectors themselves are needed, since incompetent actions on their part can ruin any carefully developed procedure. Not everyone is capable of the objective selection of talented people for subsequent joint work, some may prefer mediocrities, in order to surround themselves with faceless performers.

Thus, it should be admitted that science is not ready to suggest a satisfactory social mechanism of the selection of personnel for the reinforcement of its own ranks. It is necessary to find the stage and method of selection, to determine the criteria of selection, and to establish the order and procedure of actions.

The third step is the keeping of capable people in science. It should begin with the first months of work--precisely at the time when young specialists

are often used at vegetable bases, as typists, messengers, and so forth. Material stimuli, which will be discussed below, play here a large, but not the only role.

Further, under the conditions of a stabilized or nearly stabilized number an influx, which makes it possible to avoid stagnation, is possible only on the condition of an equivalent outflow. Thus far the outflow is occurring spontaneously--vacancies are opened up in connection with the natural turnover, retirement, and death. Practical experience shows that for the necessary updating the natural outflow should be supplemented by a forced, consciously organized outflow. A mechanism of the release of ballast, which is not only legally irreproachable, but also purposeful from a social standpoint, that is, leads to the release of those who are not of value to science, and not those whom it is easier to get rid of, is also required here; individual traits of such a mechanism were suggested long ago, but, unfortunately, so far have not been implemented.(6) The establishment by administrative means of assignments on the reduction of staff is dangerous, since in this case dismissal becomes an end in itself, and not a means of improving the personnel potential.

The second direction of qualitative development is the increase of skills. Now by the increase of skills of scientists people understand almost exclusively the preparation and defense of a dissertation. Perhaps, this happens because the established system of state certification makes it possible to evaluate officially and to record in documents so unstable a category as scientific skills. The system of the awarding of academic degrees for its most part has not been changed since 1934, although adjustments, which affected mainly the procedure, and not the principles, have been made in it. This system arouses numerous disputes and accusations of archaism and the unnecessary expenditure of the efforts and time of skilled specialists. The basic question, which arouses disputes, reduces to the following: Is the preparation of a dissertation the socially useful process of acquiring new knowledge or is this the process of casting already available knowledge into a legitimized dissertation form? In preparing a dissertation do the skills of scientists increase or do the already achieved skills just appear? For the present there is no clear answer to these questions.

The training of scientists in such forms as is now done in other spheres (periodic advanced training) is being carried out to a very small extent. In academic science it is entirely absent, in sectorial science it is used on a limited scale for people, who hold managerial positions at scientific research institutes or have been included in the reserve for their replacement. A general concept of what to teach scientists and what knowledge to add to the available store has also not been elaborated. In this matter science has also proved to be unprepared for the demands of the new stage.

But skills are not only knowledge, but also the ability to conduct research. In every field of research its own techniques, operations, and even flow charts exist. Today the researcher discovers them all over again for himself, by acquiring mastery, or adopts them from his supervisor. It must be assumed that at the present stage the technology of research will succeed individual mastery (at first, probably, in addition to it). K.F. Puzynya notes that

"...the processes of scientific creativity, which involve the development of new machines, instruments and mechanisms, materials and technologies, for the most part consist of such actions which can be quite accurately described, simulated, organized, and planned."(7) By representing scientific activity as a kind of production process, we cannot but admit the existence of a technology, which is a set of methods of actions on acquiring new knowledge and which it is possible to teach (once again let us stress that it is a question precisely of mastery, and not of talent, including the talent to discover new techniques of work--no "technology" will replace it).

The photographs of the workday of scientific associates, which were made at times, showed that, despite the significant diversions for nonscientific types of jobs, all the same they spent a large portion of the time on research. But if this, at first glance usefully spent portion of the time is subjected to a content analysis (for example, in accordance with the work logs), often an unattractive picture is revealed: an associate makes experiments, which cannot give the necessary information, or unnecessary ones, which do not give any information, turns over unnecessary specimens for analysis, reads literature that is useless for this work--all this is because of the inability to work. It is even possible to calculate the efficiency as the ratio between the amount of useful information, which was included in a report and publication and appears as the scientific result, and the total amount of obtained primary information. It will prove to be small; the lack of technological preparation is to blame for this.

The generalization and scientific interpretation of technological know-how and the elaboration of the optimum methods and schemes in combination with a high level of technical equipment are capable of increasing labor productivity in science by many fold.

The Stimulation of the Labor of Scientists

Along with the examined means of increasing, if it can be put this way, "the quality of workers of science" stimulation plays an important role in the intensification of scientific activity. The remuneration of labor acts as a vital stimulus. For the present it is still too early to judge the advantages and drawbacks of the recently introduced system of the remuneration of labor in science. It is possible to note only a few fundamental features which pertain to a vital question--precisely what serves as the object of remuneration.

Of course, remuneration, which corresponds to the end results, would be the best version. This would be the implementation of the principle of remuneration according to labor. However, the direct implementation of this principle even in applied science is complicated due to the large time gap between the expenditures of efforts and the achievement of a result, as well as due to the lack of reliable criteria of the evaluation of the results at the moment of their achievement. Remuneration should be regular and cannot wait until the value of the results is demonstrated publicly. But even if such indicators existed, it would be impossible to remunerate labor in proportion to the results due to the marked difference between the output of highly productive and unproductive workers. Whereas at a plant the output of

the best and worst worker can differ, as a rule, at most by several fold, in science the difference exceeds a hundredfold.

As a consequence of these factors so far in science mainly the process of labor is paid for (the salary, regular bonuses, increments), and only a small portion is connected with the result, and then, as a rule, not the end result (thematic bonuses). The need for the acceleration of scientific and technical progress and the obtaining of results, which can be implemented in the national economy, requires precisely the effectiveness of labor to be stimulated. The increase in the remuneration of labor of the share, which is connected with the result, is being achieved in the experiment which was begun at several production associations of Leningrad in 1983. The essence of the experiment has been covered quite extensively in the press, and here there is not need to dwell on it. Let us note the basic thing: the experiment encompasses designers and process engineers, whose labor is closest to production, is involved with the immediate production result, and to a significant degree lends itself to rate setting. The question is, is it possible to apply the principles, which have been incorporated in the experiment, to scientific research work proper?

It seems that such a means is possible and that in the next few years it will be the basic line of the improvement of material stimulation in applied science. The difficulties with the rate setting of research labor appear as the main obstacle. In order to evaluate objectively how much a worker has done, it is necessary to have for comparison a gauge--"how much he should have done." How to surmount these difficulties is a theme for a separate study.

Here science for the present is also not prepared for changes. Meanwhile they are becoming imminent, encompassing the economic, organizational, sociological, and psychological aspects of the problem. It is possible to illustrate the qualitative nature of the changes with the following example. The changeover from a regular bonus, which is proportionate to the salary, as is customary at sectorial scientific research institutes, to a temporary increment or bonus, which is connected with the production result, in the Leningrad experiment is changing the approach itself: in the former case the wage with the full bonus, which it is possible in part to lose due to negative indicators (the withholding of bonuses for offenses or oversights), serves as the psychological reference point; in the latter the salary without a bonus serves as the starting point, it is necessary to be specially recommended for it if there are positive results. In the former case it is possible to lose the bonus, in the later it is necessary to earn it. There is no need to explain in which case the stimulating effect is greater.

Thus, the changeover to the new, intensive type of development signifies that science in essence is on the threshold of a new stage, which it is possible to call the industrial stage. This changeover should become the object of careful preparation--scientific, organizational, economic, and sociopsychological.

FOOTNOTES

1. The data are cited according to the monograph: M.P. Chemodanov, "Kontseptsii rosta nauki i faktor intensifikatsii" [Concepts of the Growth of Science and the Factor of Intensification], Novosibirsk, Nauka, 1982.
2. M.S. Bastrakova, "Stanovleniye sovetskoy sistemy organizatsii nauki" [The Formation of the Soviet System of the Organization of Science], Moscow, Nauka, 1973, p 162.
3. V.I. Lenin, "Poln. sobr. soch." [Complete Works], Vol 45, p 287.
4. "On the Progress of the Fulfillment by the USSR Academy of Sciences of the Decisions of the 27th CPSU Congress and the Implementation of the Decree of the General Assembly of the USSR Academy of Sciences of 20 March 1986. Report of Vice President of the USSR Academy of Sciences Academician V.A. Kotelnikov," VESTNIK AKADEMII NAUK SSSR, No 11, 1986, pp 29-30; "Statements of the Session Participants," VESTNIK AKADEMII NAUK SSSR, No 1, 1987, pp 35-79.
5. The statement of D. Miamoto is characteristic on this level: "In Japan the custom of respecting the opinions of elders dominates. In scientific activity this has the result that remarkable ideas of young researchers cannot make their way in the world" (quoted from REFERATIVNYY ZHURNAL "EKONOMIKA PROMYSHLENNOSTI", No 7, 1982, 7 Em⁴⁶).
6. S. Mikulinskiy, "The Problem of Scientists Under the Conditions of the Scientific and Technical Revolution," KOMMUNIST, No 5, 1973.
7. K.F. Puzynya, "Creativity Also Needs a Technology," IZVESTIYA, 7 April 1985.

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AUTOMATION AND INFORMATION POLICY

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AUTOMATION, ELECTRONIZATION IN MACHINE BUILDING

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 3, Mar 87 pp 23-32

[Article by Corresponding Member of the USSR Academy of Sciences P.N. Belyanin under the rubric "Scientific and Technical Progress: Problems of Acceleration": "The Automation and Electronization of Production in Machine Building"]

[Text] Machine building is among the key sectors of the national economy, since precisely it, by providing other sectors with economical, high-performance machines, instruments, and equipment for the most different purposes, decisively influences the acceleration of scientific and technical progress both in production and in the economy of the country. The success of the work of the extractive and processing sectors, power engineering, transportation, agriculture, and the nonproduction sphere depends to a significant degree on how efficiently machine building operates. The entire USSR national economy is interested in the shortening of the time of development of new machines, the complete and rapid meeting of the need for them, and, finally, the competitive ability of items of domestic machine building on the world market and, hence, their high quality.

A large share of the responsibility for the accomplishment of the task posed by the 27th CPSU Congress--in the next 15 years to change production over to the primarily intensive means of development, to increase labor productivity by 2.3- to 2.5-fold, to decrease the materials-output and power-output ratios of the products of all sectors, and to increase by nearly twofold the national income of the country--rests with the machine building complex. The utmost increase of the efficiency of machine building production itself in our days is acquiring particular importance. Machine building can be highly efficient only if it is capable of changing over rapidly and economically to the output of a new product of better quality and of meeting in a short time the demand for it. This is possible only in case of a high level of the automation and flexibility of production.

The integrated use of computers for the accomplishment of all the tasks of production--from the designing of items, production, and marketing to the increase of their efficiency in operation--at present has become the main condition of the increase of the flexibility and degree of automation of social production.

Key:

1. Computer hardware, microelectronics, and electronics
2. Computer-aided design systems (SAPR's)
3. Automated control systems (ASU's)
4. Computer-aided instruction systems
5. Production equipment and supply
6. Information and organizational systems of service of the client (user) of the items
7. SAPR K (engineering of an object of production)
8. SAPR TPP (technological preparation of production)
9. ASU TPP (technological preparation of production)
10. ASU TP (technological processes and equipment)
11. ASU P (production)
12. ASNI (scientific research)
13. Development of concept of new item
14. Accounting and analysis of market conditions, study and formation of the demand for new items

Practical experience has shown that the greatest impact is achieved at those enterprises (particularly in science-intensive sectors of machine building--the aerospace and radio industries, in the production of computers, instruments, many vehicles, power and other equipment), where a computer is used in the entire production cycle (diagram). This cycle in the information sense is closed and has feedback. Indeed, the information on the design of a new item, which has been obtained in the SAPR K [computer-aided design system of the engineering of an object of production] on the basis of a concept developed with the aid of a computer, is fed into the SAPR TPP [computer-aided design system of the technological preparation of production] and is used for the designing of all the elements of the technological preparation of production (engineering and technical).

Automated control systems (ASU's), systems of the instruction of production personnel and automated production units, as well as information and organizational systems of the service of the client, including accounting, which is carried out by means of computer, and the analysis of market conditions (the demand for items of machine building), are formed and operate on the basis of the results of the processing of information in the SAPR K and the SAPR TPP. The results of the analysis are fed into the SAPR K for the development of the concept of the new item which will be put into production in place of the one being produced for the complete and timely meeting of the needs of the client. Such a closed system is the basis for the ideology of flexible machine systems and does not depend either on their nature (be they mass or small-series and even custom-made) or on their technical equipment (whether general-purpose production equipment or automatic lines--flexible, rotary, and others--are used in them).

Production electronization is proceeding in many directions, in particular, the greater and greater saturation of diverse production equipment with microelectronics and electronics is occurring. Electronic control systems, as well as components and assemblies of electronics are being used more and more extensively, for example, in units for the plasma and beam machining of parts,

The first domestic adjustable multiple-range flexible production line (Figure 1) consisted of two modules,(2) but individual elements of the SAPR TPP and the ASU P [automated control system of production] were already envisaged in its structure. This line, which is controlled by an M-6000 computer, operated successfully during the entire past five-year plan and continues to be operated at present. The ALP3-2 flexible production complex, which consisted of 8 modules--a kind of automated shop for the machining of the entire range of complex base members (more than 70 descriptions)--was developed on its basis. Parts measuring 250 X 250 X 250 millimeters and made from various light alloys undergo in the shop complete machining, including the milling of complex surfaces, the boring of sockets, grooving, the drilling of holes, including deep holes, and the cutting of threads. The production of parts is small-series and custom with a changing range, here there is no need for the lengthy readjustment of equipment. The changeover time to the machining of a new (true, previously assimilated) part does not exceed 20 seconds, which testifies to the great flexibility of this entire complex system. The ALP3-2 takes up little space--55.5 X 19.4 square meters.

The ALP3-2 complex has 8 five- and six-position NC machine tools like the "machining center," which have automatic magazines for 60 tools made up of 8 modules.(3) It also has an automated transfer and warehousing system of the blanks (parts) being machined, an automated transfer and storage system of tool supply for 1,420 tool adjustments in a central storage unit with 2 robot transfer arms, and a system of the automated removal of chips, which is controlled by a computer system based on the SM-2M computer. Within the complex there are a division of the delivery of complete sets of blanks, the adjustment of tools and attachments, final inspection, and the automated washing of parts and a central control console. In each flexible production module in addition to a machine tool with the automatic change of tools there are an automatic loading and unloading unit and a control system.

A computer-aided design system of technological processes (SAPR TP) and a computer-aided design system of control programs (SAPR UP), as well as a system of the automated planning, dispatching, and control of production are a fundamental part of the ALP3-2 complex.

The man-machine SAPR TP makes it possible to develop the operational technology of the machining of parts, here man coordinates the information contained in the drawing of the part, feeds it into the computer, and establishes the route, while the computer selects the datum surfaces and issues the necessary information on the operations, the machining conditions, the manufacturing steps, and so forth.

The interactive SAPR UP carries out the computation of programs for the machine tools, which are included in the flexible production modules, here a video terminal is used.

The ALP3-2, like other similar complexes, makes it possible to increase labor productivity by eight- to tenfold (as compared with traditional general-purpose machine tools), frees 50-90 machine tool operators, and reduces the need for production equipment to one-seventh to one-tenth.

The introduction of the complex increased the output of products by 2.5- to 3-fold, here the equipment shift coefficient increased to 2.4-2.5, while its utilization ratio increased to 0.8-0.9. The losses of working time were reduced, product quality increased, and, what is the main thing, the rapid changeover (by the change of the control programs) from the machining of a part of one configuration, type, and size to another within the bank of control programs and technological possibilities of the machine tools became possible.

The use of the SAPR TP and SAPR UP in all cases shortens the time of the engineering preparation of production to one-third to one-half and decreases its labor intensity to one-fifth to one-third (as compared with traditional methods).

Interconnection and interpenetration are characteristic of the SAPR's and ASU's, which are used in flexible machine systems. The division of automated complexes into control systems of equipment, processes, and production and various SAPR's is conditional. This conditionality consists not so much in the lack of clear boundaries between systems as in the need for the fundamental compatibility of their structure and architecture. Unfortunately, so far the technical assignments and designs of the programs of flexible automated complexes are being developed as a set of unconnected systems or systems which are not interconnected enough. The architecture of the unified program system, not to mention the architecture of the entire control system, is not considered at all. This leads not only to the underestimation by developers of related systems of programs, but also to the lack of a unified system of the functioning of flexible machine systems. At present, when there are practically no fully functioning flexible machine systems, the lack of coordination of program systems is not very noticeable. However, there is every reason to assume that the further ignoring of the unified architecture of the system of control and designing of flexible machine systems will cause difficulties and even the impossibility of the integration of previously introduced flexible automated modules into a unified complex.

The unified architecture of the software and hardware system implies the development of a quite complete list of its informally specified functions and their interrelations, including the functions on control and designing, the mechanisms of the interaction of individual parts with each other, user interfaces, and so forth. The creation of a knowledge base with a set of informally formulated fields and subfields of their storage and mechanisms of access to these knowledge and data and their adjustment is also necessary.

The lack of a concept of a unified architecture of the software and hardware control and designing system of flexible machine systems does not make it possible to develop an operating system which supports this architecture. Difficulties arise in the efficient integration of several operating systems, under the control of which the software and hardware, which are practically not interconnected, operate. These difficulties are caused first of all by the different time scale, on which the operating systems function. The control of the actuators of equipment and the regulation of technological

processes takes place on a real time scale with a response to an inquiry of not more than 0.5-2 milliseconds; the control of individual units of equipment and its assemblies is also carried out on a real time scale, but with a response to an inquiry of 1-2 to 4-5 milliseconds, while the response to an inquiry when controlling a flexible production module is from 1-2 to 10-15 milliseconds, which is connected with the need to coordinate the movements of units included in the flexible modules, which differ in speed. The control of flexible production sections and shops is carried out by a large number of different systems, which operate both on a real time scale with a response to an inquiry of 1-2 milliseconds and on a quasireal time scale with a response to an inquiry from 3-5 milliseconds to 2-3 milliseconds and even on an unreal time scale (within the framework of designing and organizational control).

All the listed program systems can be efficiently supported by various operating systems and require for their functioning different operating modes of the control computers. This difference in modes is due first of all to the limitations, which are placed on the types and size of the memory which is used by different operating systems (the main, read-only, and variable read-only memories, magnetic disks and tapes, and so forth); the impossibility of the execution of the program in individual parts, which are called to the main memory from an external program medium (magnetic disk) in sequence, on a real time scale, and with rapid responses to an inquiry; the impossibility of placing a large part of (if not the entire) real-time operating system in the read-only or variable read-only memories. Let us also note that different operating systems for their efficient operation use different interrupt mechanisms, user interfaces, and so forth. Obviously, the integration of all these operating systems or the development of a unified operating system is not so trivial and, apparently, requires the use of functional computers and the principles of artificial intelligence.

In functional computers a large portion of the programs should be implemented by the hardware, particularly in very large-scale integrated circuits. Such computers in the immediate future, apparently, will constitute the basis of the control computer network of flexible machine systems. In composition and structure the functional computer should be no poorer than the general-purpose computer that corresponds to it, but for the accomplishment of the difficult task of controlling large flexible production complexes it should be specialized for its designated purpose.

The real-time operating systems of flexible machine systems, which are intended for the monitoring of the running of all the program modules within the computer control complex, as well as for the control of the operation of the data input-output devices on a real time scale, should be quite universal.

The knowledge banks, which are necessary for the efficient operation of large control complexes of flexible machine systems, should contain not only the usual information (the data on the parameters), but also various descriptions, arguments, and logical constructs, which are not strictly formalized.

Key:

1. Functional modules
2. Algorithm
3. Implementation unit
4. Solution
5. Data
6. Compiler of subject area
7. Description of algorithm
8. Parameters
9. Designer of subject area
10. Optimization parameters
11. Data bank
12. Compiler of dialog
13. Knowledge bank
14. Context (state of external environment)
15. Compiler of knowledge base
16. Generator of programs
17. Context

In the control systems of flexible machine systems with especially great adaptation capabilities it is advisable to use natural language for interaction with the control computer (or the computer which operates in the control network). Such a language is practically unlimited, since it is formed in accordance with the principle of the coherence of syntax and semantics, that is, the dependence of the meaning of a word on the context. The use of natural programming languages affords new opportunities for the automation of the technological preparation of production of flexible machine systems.

The necessity of using in SAPR's and ASU's of the principles of artificial intelligence has arising in modern production, which is developing rapidly and constantly becoming more complex. They were developed during the 25-year evolution of software and hardware, which are intended for the solution of the entire set of complex production problems in machine building. This evolution is seen most clearly from the example of the SAPR of control programs for NC machine tools (Figure 2).

The control program in any case is an algorithm of the machining of a part, which is written in a form comprehensible to the computer.

At the first start (starting in 1960) the algorithm of the control of NC machine tools was given by man in computer codes--that is how the domestic UKP, SPPS, and APOP programming systems and several foreign systems operated. The strict assignment of the algorithm of the development of control programs of the machine tool is characteristic of this stage, moreover, in addition to the algorithm, in computer language man also feeds into it the data necessary for the accomplishment of a specific task (in Figure 2 everything that is performed by man is noted by the corresponding symbol, the functional modules are the software, while the implementation unit is the computer itself). The change of the algorithm required reprogramming.

At the second stage (starting in 1965) when developing control programs everything was done as at the first stage, only the algorithm, which was written in not computer codes, but in a problem-oriented language, was compiled in these codes by means of a compiler of the subject area. The domestic SAP-2, SAPS, SAP-3, SAP-5, APT-YeS, and APT-SM automated programming systems and the foreign systems of the APT family were formed in this way.

At the third stage (starting in 1970) the storage of the developed algorithms in the memory of the computer was envisaged by the automated program systems. The necessary algorithm (for the computation of the control programs of the production of the given item) was selected from among those available in the memory of the computer by means of optimization parameters. These parameters were fed by man into the layout unit of the subject area, which makes it possible to select the optimum version of the algorithm from the available set. The domestic SPS-TAU and SAP-TEKhNOLOG programming systems and such foreign systems as the EXAPT and NELNC family operated according to such an arrangement.

The automated programming systems, which were developed at the fourth stage of evolution, which began in 1975, envisaged the selection of the necessary algorithm by the making of decisions in the interactive mode at the points of the branching of the algorithm. The software and hardware of the domestic APT ISKRA automated programming system and the foreign systems of the APT DIALOGUE family were formed in this way. The elements (parts) of the algorithm and the conditions of its branching (generation) are stored in their databases. Man in the mode of interaction with the computer selects the direction of the branching of the algorithm.

The artificial intelligence systems, which are being developed at the present, fifth stage of evolution, have the greatest perfection. All the information on the subject area, with which the system of programming, designing, or control interacts, is gathered in their knowledge bank. In this case (as in all artificial intelligence systems) the context (the information on the external environment) accomplishes the branching of the algorithm. Instead of an algorithm a generator of programs, which operates, on the one hand, on the basis of the information of the knowledge bank and, on the other, on the basis of the context through the compiler of the knowledge base, is used in artificial intelligence systems. Here a portion of the context enters the knowledge bank and causes the "development" of artificial intelligence. For example, the control program for an NC machine tool is not selected, but is generated by the artificial intelligence system each time all over again and in a more and more perfect manner.

The knowledge banks are the most important part of artificial intelligence systems. Highly skilled process engineers and designers, who know how to interact with computers, are required for their development.

A few artificial intelligence systems, which are oriented toward the computer-aided solution of the problems of the technological development of production, have been developed in our country. One of them--the artificial intelligence system of the designing of technologies of machine building--was developed

under the scientific supervision of Academician N.G. Bruyevich.(4) In it the laws of logic (axioms of logic and rules of deduction), as well as the laws of the technology of manufacturing (machining, assembly) and production are entered in the knowledge bank, the drawing of the part, for the manufacturing of which it is necessary to develop the technological process on computer, is the context. This system is a general-purpose one: it is capable of proposing a technological process for the production of a part of any design.

An artificial intelligence system of the designing of programs of flexible machine systems has also been developed. A natural language of the description of the production problem and a compiler, which on the basis of the base of production technology knowledge and the database of the operating system creates (generates) or adjusts the memory of the real-time operating system, which then works with the context (the information being received from the sensor of the external environment), are used in it. Programs of the functions of the hardware of flexible machine systems are the commodity product of the system. As compared with the programming systems being used the artificial intelligence system makes it possible to decrease the labor intensity of the development of programs to one-twentieth to one twenty-fifth and the cycle of their development to one-fifteenth to one-twentieth, here the reliability of the programs increases by five- to tenfold, while the labor intensity of their attendance decreases to one-fifteen to one-twentieth with the simultaneous two- to threefold lengthening of the life of the program product.

The tasks of the further automation and electronization of production require not only new artificial intelligence systems of SAPR's and ASU's to be developed and the output of 32-bit computers to be organized, but also a branched network of computers as intelligent terminals, which contain a display, a keyboard, a disk unit, a printer, and other units, to be developed. In addition to this, it is necessary to form a system of banks of technological and economic organizational knowledge and data banks, as well as to change over to the extensive operation of shop, plant, and sectorial computer networks. At present several models of 16-bit professional computers (the YeS-1840, the Elektronika NTs-80-20/4, Elektronika MS-0585, and VEF Mikro-1025 digital computer complexes, the YeS-7970.01, and others) have been developed. All of them can be used both in automatic mode and in local and global computer networks for the solution of a wide range of economic, design, management, and other problems of production. The mass production of these computers together with other measures on automation and electronization is necessary for the increase of the efficiency of machine building as a whole.

FOOTNOTES

1. See V.M. Makarov, "Sovremennyye metody povysheniya konkurentosposobnosti magistralnykh samoletov na mirovom kapitalisticheskem rynke (Marketing v aviastroyenii: voprosy teorii i praktiki)" [Advanced Methods of Increasing the Competitive Ability of Long-Haul Aircraft on the World Capitalist Market (Marketing in the Aviation Industry: Questions of Theory and Practice)], Moscow, Mashinostroyeniye, 1976.

2. See P.N. Belyanin, "Promyshlennyye roboty" [Industrial Robots], Moscow, Mashinostroyeniye, 1975.
3. See "Gibkiye proizvodstvennyye kompleksy" [Flexible Production Complexes], edited by P.N. Belyanin and V.A. Leshchenko, Moscow, Mashinostroyeniye, 1984.
4. See N.G. Bruyevich, P.N. Belyanin, B.Ye. Chelishchev, A. Gonzalez-Sabater, "The Mathematical Theory of the Technology of Assembly," DOKLADY AKADEMII NAUK SSSR, Vol 246, No 6, 1979, pp 1310-1313; N.G. Bruyevich, P.N. Belyanin, B.Ye. Chelishchev, "An Artificial Intelligence System of the Designing of Technology," MASHINOSTROYENIYE, No 1, 1983, pp 3-7.

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FORMATION, DEVELOPMENT OF AZERBAIJAN SCIENTIFIC POTENTIAL

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[Article by G.A. Gyandzhiyev: "Regional Peculiarities of the Formation and Development of the Scientific Potential"]

[Text] In the new version of the Program of the Communist Party of the Soviet Union, which was adopted by the 27th CPSU Congress, it is indicated: "Party policy in the area of science is aimed at the creation of favorable conditions for the dynamic progress of all fields of knowledge and the concentration of personnel and material and financial resources in the most promising directions, which are called upon to expedite the achievement of the outlined economic and social goals and the spiritual development of society and to ensure the reliable defensive capability of the country."(1) Regional science is playing an important role in the accomplishment of these strategic tasks.

It should be noted that at present a large quantity of personnel, material and technical, financial, and information resources, which in combination with specific organizational principles and the structure of management characterize the aggregate potential of science, are functioning in the Azerbaijan SSR. In the number of employees, the amount of expenditures, and the number of institutions and organizations science in the republic has achieved the scale of the leading sectors of the national economy.

The specialization of the national economy for many years in many respects determined the directions of scientific research of the republic. The most significant successes of Azerbaijan science are connected with achievements in the development of petroleum and gas deposits, petroleum refining, and petrochemistry. The petroleum industry was the most important factor, which influenced the formation and development of many sectors of the national economy of the republic, including science. This factor is also at present continuing to play its decisive role. Suffice it to note that such sectors as the fuel industry, the petrochemical industry, petroleum machine building, and others were developed on the basis of petroleum, which served as a powerful stimulus for the development of the corresponding fields of science. Thus, an extensive network of scientific research institutes, which are conducting research in the area of the development of new methods of the production and refining of petroleum and gas, has been developed in Azerbaijan.

This finds its reflection in the structure of the number of scientists and the expenditures on the development of science. At the Azerbaijan SSR Academy of Sciences alone the share of the expenditures, for which the chemical sciences (which are connected mainly with the problems of petrochemistry) account, in 1984 came to about 26.3 percent. For comparison let us indicate that in 1976 it came to 23 percent.

It goes without saying that the resources of the sphere of science and scientific service of the individual union republic are a fundamental part of the aggregate scientific and technical potential of the country. However, the change of the structure of science itself occurs subject to the specialization of the economy of the republic. Thus, the transformation of Azerbaijan into a large industrial region of the country subsequently contributed to the rapid development of the technical sciences.

It should be indicated that in addition to the specialization of a specific region the aggregate resources of science for the most part are formed under the influence of such most important factors as the economic status of the republic: the planned rate of its development; the formed structure of the national economy and its planned reorganization; the laws of the development of science and technology; the level of development of secondary specialized and higher education, and so forth.

The accumulations of society are the source of the formation of the aggregate resources of science: "...these accumulations appear in the form, first of all, of the state, as well as kolkhoz-cooperative accumulation of resources, which are necessary for the development of science and technology of the national economy."(2) On the basis of the foregoing let us attempt to substantiate the basic regional peculiarities of the formation of the resources of science in the Azerbaijan SSR. First of all it must be pointed out that the process of the formation of the resources of science and the use of the means of the main source of the formation of the aggregate potential of science in our country is of a systematic nature. In spite of the fact that the principles and legal bases of the formation of the aggregate potential on the scale of the country are the same, there are a number of regional peculiarities which play a decisive role in the process of the formation and development of the resources of science in the union republics.

In the Azerbaijan SSR in contrast to large union republics the resources of science as a whole and its active element in particular--scientists--until the early 1970's were formed mainly under the conditions of a surplus of immobile manpower resources. Since the second half of the 1970's in contrast to the historically established preceding periods the occurring and planned structural changes in the national economy of the republic played an important role in the formation and development of the resources of science.

As is known, during the years of the 10th Five-Year Plan the party and government adopted the policy of the rapid improvement of the structure of the leading sector of the economy of the republic--industry--for the purpose of accelerating economic growth and increasing the contribution of the republic to the solution of major all-union socioeconomic, scientific and technical,

and other problems, as well as for the significant increase of the standard of living of the population of the republic. On this level the decree adopted by the CPSU Central Committee and the USSR Council of Ministers, "On the Results of the Consideration of the Proposals of the Azerbaijan CP Central Committee on the Development of Individual Sectors of Industry of the Republic in 1976-1980," played an exceptional role. The indicated decree was the start of a qualitatively new stage in the process of establishing new advanced sectors of industry in the republic and in the rapid development of the sectors which govern scientific and technical progress.

Of course, the efficient functioning of the established new advanced, science-intensive, energy-saving, nonmetal-consuming, and waste-free sectors of industry made new demands on science. The need to solve a number of sectorial and intersectorial scientific and technical problems in the republic arose. And this, in turn, led to the establishment of new scientific, planning and design, technological, and other organizations in the republic.

The scientific support of the new sectors contributed to the change of the structure of the total expenditures on science, at the expense of which manpower, financial, material, technical, and other resources were formed and continue to be formed.

It should be pointed out that the extensive type of expanded reproduction requires a flexible approach in all the sectors of the national economy, particularly in the sphere of science and scientific service. Therefore, at present in the process of forming and developing the aggregate potential of science it is necessary to take these peculiarities into account. On the basis of the above, in our opinion, it is advisable to carry out the scientific support of new advanced sectors of industry mainly by means of existing resources, including manpower resources, by improving their qualitative characteristics. In our opinion, by the slowing of the pace of the training of scientific personnel in traditional fields of science it would be possible to intensify the organization of the training of highly skilled scientists, for whom the advanced sectors of industry, which govern scientific and technical progress, have an urgent need. The solution of this problem to a certain degree will make it possible to avoid the extensive means of development of science in the republic. It should be noted that primarily the extensive means of development prevailed up to the early 1960's. For example, whereas prior to 1965 the doubling of the number of employees in the sphere of science in the republic occurred on the average every 5-8 years, after that year nearly 18 years were required for its doubling. Approximately the same growth rates are also observed among scientists and science teachers.

The leading pace of development of science was also maintained in subsequent years, which is witnessed by the fact that whereas during the period from 1940-1960 the number of workers and employees increased by 1.5-fold, the number of people employed in science increased by 3.1-fold, while the number of scientists and science teachers increased by 3.7-fold. For comparison let us note that the growth of industrial output during the same period came to a little more than 2.8-fold, while the growth of the gross output of agriculture came to twofold.

The rapid development of the network of scientific research institutions with their simultaneous consolidation occurred during the period in question. Thus, in 1960 the number of scientific institutions increased to 97 and on the average there were 230 workers per institution, while in 1940 these indicators came to 60 and 120 respectively.

The parameters of the growth of manpower resources of science during these years are clearly illustrated by the data cited in Table 1. As is evident from the table, the increase of the number of people employed in science and scientific service was accompanied by the steady increase of their proportion in the total size of the employed population. In 20 years (1940-1960) it exceeded 2.5-fold. Their share in the total number of workers and employees also increased at the corresponding pace. It should be noted that due to the great prestige of scientific occupations during the period in question, which was stimulated by a high wage and good prospects of professional advancement, the number of people wishing to devote themselves to scientific activity steadily increased. Moreover, the leading role in carrying out scientific research activity belonged to the republic higher school. True, at that time the trends toward its loss of leading positions had already emerged. Thus, whereas in 1950 about 60 percent of all scientists and science teachers worked at higher educational institutions, in 1960 a little more than half did.

Table 1

Relative Indicators of the Increase of Scientists in the Azerbaijan SSR(3)

<u>Indicators</u>	<u>Unit of measurement</u>	<u>1940</u>	<u>1950</u>	<u>1960</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>	<u>1983</u>
Proportion of people employed in science:								
a) in total size of employed population	percent	0.6	0.8	1.5	1.5	1.5	1.5	1.5
b) in total number of workers and employees	percent	1.5	1.9	3.0	2.9	3.1	2.9	2.9
Per 10,000 people:								
a) people employed in science	people	23.1	36.8	60.8	71.5	80.9	84.2	86.8
b) scientists and science teachers	people	6.0	11.5	19.5	32.9	37.4	35.7	35.6
Per 100 specialists with a higher education, scientists, science teachers	people	9.7	7.6	9.9	13.2	11.0	8.5	7.8

During the period from 1940 to 1960 the number of people employed in science per 10,000 people of the republic increased by 3.1-fold, while the number of scientists and science teachers increased by 5.5-fold. At the same time the number of scientists per 100 specialists with a higher education, who are employed in the national economy, increased by only 36.1 percent. This can serve as a basis for conclusions about the achievement during the period in

question of a specific balance of the increase of specialists with the highest skills and scientists and science teachers.

As a whole it is possible to state that prior to 1960 the process of the rapid increase of the resources of science occurred in the Azerbaijan SSR. At the same time, in spite of the rapid pace of development of the sphere of science and scientific service of the republic, in many cases it was inferior to the average union indicators. Thus, whereas in 1940 the indicators cited in Table 1 significantly surpassed the average union indicators, but the middle of the 1960's the ratio had changed in favor of the latter. Here one should note the by no means unimportant fact that whereas the ratio between scientists and auxiliary scientific personnel as a whole for the country remained practically at the same level (1940--1:2.68, 1965--1:2.6), in Azerbaijan it changed significantly. Thus, in 1940 there were 28 auxiliary scientific personnel per 10 scientists and science teachers, while by 1965 the number of the former had decreased to 13, or by a factor of 2.2.

This testifies first of all to the fact that given the rapid development of the network of scientific institutions and the increase of the manpower resources of science of the republic the questions of the development of the design and pilot experimental base of science were relegated to second and even third place. As a result there could also be no talk during that period of the formation of a well-adjusted "research-production" system. The consequences of the noted disproportion in the development of the individual components of the aggregate potential of science are also having an effect at present.

Since the late 1960's and early 1970's substantial changes, which are connected first of all with the increase of not so much the quantitative as the qualitative indicators, have been occurring in the sphere of science and scientific service. These changes are due to a large number of factors, from which it is possible to single out the following as the basic ones:

--the acceleration of the changeover of all the units of the national economy of the republic, including the sphere of science and scientific service, to the primarily intensive means of development;

--the changes in the sectorial structure of the national economy, which are due to the appearance and development of new advanced and science-intensive sectors;

--the change of the role and place of the republic in the unified national economic complex of the country;

--the limitation of the possibility of allocating manpower, material, technical, and other resources for the development of science and scientific service, and others.

The changeover of science to the intensive means of development is one of its most important peculiarities at the present stage. As was noted at the 27th CPSU Congress and at the conference in the CPSU Central Committee on questions of the acceleration of scientific and technical progress on 11-12 June 1985,

our country is at such a stage of its development, when the making of a major change not only in the economic orientation of the country--the assurance of a significant increase in the well-being of the people--but also in the orientation of the management of social production--the shift of the emphasis to intensive methods of managing the economy for the purpose of increasing its efficiency without particular additional investments of labor and assets--has become necessary. This factor encompasses all aspects of scientific activity. Its influence is characterized by the slowing of the growth rate of the number of scientists and science teachers, the increase of the share of scientists with the highest scientific skills, the increase of the technical equipment of scientific labor, and so on.

At this stage of economic and social development, when large-scale renovations are being carried out in the sectors of the national economy, the role of science is increasing immeasurably.

General Secretary of the CPSU Central Committee M.S. Gorbachev in the Policy Report of the CPSU Central Committee to the 27th Congress of the Communist Party of the Soviet Union said: "The CPSU will consistently pursue a policy of the utmost strengthening of its material and technical base and will create the conditions for the fruitful activity of scientists. But the country has the right to expect of them discoveries and inventions, which ensure truly revolutionary changes in the development of equipment and technology."(4) The tasks of the intensive and efficient use of the resources accumulated in science, the close integration of science and practice, and the improvement of the forms and methods of their interrelations are being placed in the forefront. They encompass the pace and internal proportions of the sphere of research and development, the sectorial structure of scientific research, the interrelationship with the other spheres of social activity, and the forms and methods of the management, organization, and planning of science.

Table 2

Average Annual Growth Rate of the Size of Individual Groups
of the Population During 1950-1983 (percent)(5)

	<u>1950-1965</u>	<u>1966-1980</u>	<u>1981-1983</u>
Entire population	3.1	1.9	1.6
People employed in national economy	3.25	2.85	2.75
Workers and employees	4.1	3.45	2.8
People employed in science and scientific service	6.65	4.1	2.65
Scientists and science teachers including:	9.05	3.9	1.5
doctors of sciences	6.55	7.0	0.75
candidates of sciences	8.3	6.9	2.8

As the data for the latest period show, the tendency for the growth rate of the number of personnel of science to decline with each year is acquiring a more and more obvious nature. The average annual growth rate of the size of

individual groups of the population for the period of 1950-1983 is cited in Table 2.

First of all the sharp decrease of the average annual growth rate of the size of all the groups of the population in question without exception attracts attention. Here, if we compare the indicators of the increase of the size of the entire population and the number of scientists, it is evident that up to 1980 the latter increased much more rapidly. Thus, during 1950-1965 the lead factor came to 2.9, while during 1966-1980 it came to 2.1, but in recent years it has already decreased to the level of 0.9, that is, the number of scientists has increased more slowly than the entire population. At the same time the average annual growth rate of people employed in the national economy has remained practically unchanged and significantly surpasses the indicators examined above.

Among the basic causes of this process first of all it is possible to single out the decline of the growth of the population and the formation of a complex demographic situation in the republic. On the one hand, there are a significant number of people who are not employed in social production (children of school age; old people who have reached retirement age; women with many children, who due to the lack of appropriate training are not capable of mastering the technological processes of production and control systems) and, on the other, a significant shortage of skilled manpower resources.

If we take into account that a long time is required for the training of scientific associates, it is practically impossible, of course, to supplement their ranks by means of people who are not involved in social production. The latter are being assigned mainly to physical production and the service sphere, which is also responsible for the relatively high growth rate of the number of workers and employees, who are employed in the national economy.

From the data of Table 1 it is evident that all the indicators cited in it after 1960 either decreased or stabilized. Thus, the proportion of the people employed in science in the total size of the employed population to all appearances has achieved its optimum value and has remained at the level of 1.5 percent. It is also possible to say this with respect to the proportion of workers of science in the total number of workers and employees, the indicator of which even decreased somewhat--from 3 percent in 1960 to 2.9 percent in 1983.

At the same time the indicators of the number of people employed in science and the number of scientists per 10,000 people continued to increase, although at a substantially slower pace. This is explained not so much by the high growth rate of scientists as by the sharp decline of the natural growth of the population of the republic and the influence of a number of social and demographic factors.

Since 1970 the number of scientists and science teachers per 100 specialists with a higher education has decreased appreciably, having fallen to nearly 2.5 percent below the 1940 level.

It is well known that young people, mainly specialists who have graduated from higher educational institutions, are playing an important role in the process of the reproduction of scientists of the republic. In this connection the comparison of the data on the graduation of specialists by higher educational institutions and admission to graduate studies is of definite interest. For the achievement of comparability the graduation of specialists by higher educational institutions was organized by groups of specialties which correspond to the individual fields of science. For example, economics--the economic sciences, chemical technology--the chemical sciences, and so on. At the same time an attempt was made to link the basic directions of the development of the national economy and the sphere of science, particularly the development of manpower resources. In this case it was assumed that the training of specialists with a higher education is planned in strict conformity with the present and long-range need of each specific field and reflects to some extent the trends of its development. Thus, for example, during the period of 1970-1983 the number of specialists trained in the field of geology and mineral prospecting decreased by 8.3 percent, while in the specialties of machine building and instrument making it increased by 2.2-fold.

During the period from 1976 to 1982 the ratio between admission to graduate studies and the graduation of highly skilled specialists by fields of sciences was maintained at approximately the same level.

However, as a whole it is impossible to speak about the existence of a strictly legitimate dependence between the graduation of specialists with a higher education and admission to graduate studies with a breakdown by individual fields. In addition, it should be noted that in recent years a sharp decrease of the influx of specialists with a higher education into the sphere of science and scientific service of the republic has been observed; moreover, this process is advancing rapidly. As is evident from Table 3, during the period from 1975 to 1983 the growth rate of the number of specialists with a higher education in the sphere of science and scientific service was significantly less not only than the average republic growth rate, but also as compared with the leading sectors of the national economy--industry and agriculture.

Table 3

Growth Rate of the Number of Specialists With a Higher Education
in the Azerbaijan SSR (percent)(7)

	<u>1976-1980</u>	<u>1981-1983</u>	<u>1976-1983</u>
National economic as a whole	134.1	113.2	152.0
including:			
industry	146.4	120.4	176.2
agriculture	152.3	119.1	181.4
science and scientific service	119.4	107.2	128.0

Of course, one should not expect under such conditions any significant increase of the influx of young specialists into the sphere of science of the republic.

In speaking about the basic causes of the decrease of the growth rate of the number of scientific associates, especially young specialists, it is impossible to evade the question of the remuneration of the labor of workers in the sphere of science. As is known, in the time that has passed since 1960 the workers of science as a whole for the country in the level of the remuneration of labor have moved from first to fourth place, having let industry, transportation, and construction ahead.

The disproportion between the development of the economy of the republic and its aggregate potential of science during the period in question is clearly illustrated by the data of Table 4. As is evident from the table, the contribution of the Azerbaijan SSR to the production of the gross national product of the country increased from 1.01 percent in 1960 to 1.31 percent in 1983, while its contribution to the production of the national income increased from 1.6 percent to 2.0 percent respectively.

Table 4

The Proportion of the Azerbaijan SSR in the USSR, percent(8)

	1960	1970	1980	1983
Gross national product	1.01	1.01	1.34	1.31
Produced national income	1.60	1.31	1.96	2.00
Scientists	2.04	1.83	1.60	1.60
Expenditures on science	0.49	0.54	0.49	0.43

At the same time the proportion of workers of republic science in the total number of scientists and science teachers decreased significantly. This occurred as a result of the lag of the growth rate of the number of scientists of the republic behind the average union growth rate, for the reasons stated earlier. But the somewhat premature limiting of the expenditures, which are being allocated for the development of republic science and which have a decisive influence on the formation and development of individual types of resources, played the main role in this process.

As is evident from Table 4, the share of these expenditures in the all-union expenditures on science is much less than the economic return of the national economy of the republic.

As a result of the early changeover to an "austerity policy" a significant shortage of scientific specialists in many fields of science and technology formed in the area of science. At present in Azerbaijan the number of specialties, in which scientists and science teachers are being trained, comes to only about 70 percent of the number of specialties, in which scientists and science teachers of the country are being trained. At the same time that in many regions of the country the emphasis has been placed on the expansion of research in the majority of fields of the natural sciences, which govern

further scientific and technical progress, in the republic such specialties of the technical sciences as low-temperature physics, radiophysics, chemical kinetics and catalysis, polymer physics and mechanics, plastic metal working, and others have remained in embryo.

True, it should be noted that new advanced sectors of industry--radio electronics, scientific instrument making, electrical engineering, robotics, microelectronics, and others--which brought about such areas of scientific research as the technology of instrument making, powder metallurgy, semiconductor microelectronic instruments and measuring equipment, the technology of chemical fibers, systems programming, and many others, have formed and developed in recent years. But, unfortunately, so far not all sectors of the national economy have yet been completely provided with the appropriate scientific base and, consequently, have not been encompassed by scientific research.

FOOTNOTES

1. "Programma Kommunisticheskoy partii Sovetskogo Soyuza (Novaya redaktsiya)" [The Program of the Communist Party of the Soviet Union (New Version)], Moscow, 1986, p 57
2. P.A. Kulvets, "Problemy ekonomicheskoy effektivnosti ispolzovaniya nauchno-tehnicheskogo potentsiala" [Problems of the Economic Efficiency of the Use of the Scientific and Technical Potential], Vilnius, MINTIS, 1978, p 17.
3. "Narodnoye khozyaystvo Azerbaydzhanskoy SSR v 1984 g. (Statisticheskiy yezhegodnik)" [The Azerbaijan SSR National Economy in 1984 (A Statistical Yearbook)], Baku, 1985, pp 13, 28, 144, and 207.
4. "The Policy Report of the CPSU Central Committee to the 27th Congress of the Communist Party of the Soviet Union," PRAVDA, 26 March 1986.
5. "Azerbaydzhanskaya SSR k 50-letiyu Velikogo Oktyabrya. Statisticheskiy sbornik" [The Azerbaijan SSR on the 50th Anniversary of Great October. A Statistical Collection], Baku, 1967, pp 9, 147, 204 and "Narodnoye khozyaystvo Azerbaydzhanskoy SSR v 1984 g. (Statisticheskiy yezhegodnik)," Baku, 1985, pp 13, 19, 28, and 144.
6. The calculation was made on the basis of the data of: "Narodnoye khozyaystvo Azerbaydzhanskoy [line omitted from original]" [The National Economy of the Azerbaijan...], 1971, p 533 and "Narodnoye khozyaystvo SSSR v 1984 g. Statisticheskiy yezhegodnik" [The USSR National Economy in 1984. A Statistical Yearbook], Moscow, 1985, pp 103, 107, and 124; "Narodnoye khozyaystvo Azerbaydzhanskoy SSR v 1984 g. (Statisticheskiy yezhegodnik)," Baku, 1985, pp 28, 29, and 151.
7. "Narodnoye khozyaystvo SSSR v 1970 g. Statisticheskiy yezhegodnik" [The USSR National Economy in 1970. A Statistical Yearbook], Moscow, [line omitted from original], "...SSR k 60-letiyu obrazovaniyu SSSR" [...SSR on

the 60th Anniversary of the Formation of the USSR], Baku, 1982, p 271, and "Narodnoye khozyaystvo Azerbaydzhanskoy SSR v 1984 g.," Baku, 1985, p 210.

8. "Narodnoye khozyaystvo SSSR v 1970 g. Statisticheskiy yezhegodnik," Moscow, 1971, pp 60 and 533; "Narodnoye khozyaystvo SSSR v 1984 g. Statisticheskiy yezhegodnik," Moscow, 1985, pp 59, 103, 107, and 424; "Narodnoye khozyaystvo Azerbaydzhanskoy SSR v 1984 g. (Statisticheskiy yezhegodnik)," Baku, 1985, pp 20, 23, 25, 28, 29, 151.

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MANAGEMENT OF UKRAINIAN S&T PROGRESS ON BASIS OF AUTOMATION

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[Article by V. Shevchenko, chief of a department of the Ukrainian SSR State Planning Committee, and Candidate of Technical Sciences V. Ruban under the rubric "For Propagandists and Students of the System of Economic Training": "The Improvement of the Management of Scientific and Technical Progress in the Republic on the Basis of Integrated Automation"]

[Text] The 27th CPSU Congress devoted foremost attention to the rapid updating of the production system by the extensive introduction of advanced equipment, the most advanced technological processes and flexible systems, integrated mechanization in all the sectors of the production and nonproduction spheres, and the automation of production with the changeover to automated shops and plants, the development of automated control and computer-aided design systems, and the large-scale computerization of production.

In our republic during the 11th Five-Year Plan the necessary prerequisites were created for the accomplishment of the tasks posed by the party. As was noted at the 27th Ukrainian CP Congress, atomic energy, instrument making, electronics, the electrical equipment industry, and other sectors, which govern scientific and technical progress, developed at a leading pace. The integrated mechanization and automation of production processes and the introduction of advanced types of equipment and the latest technologies made it possible to save the labor of 3.8 million people. The pace of the decrease of the materials-output ratio was nearly twofold greater than the planned pace, which made it possible to save material and technical resources worth 3.7 billion rubles.

Purposeful work on the improvement of the management of scientific and technical progress and the strengthening of the planning element in the development of science and technology is being performed in the republic. Foremost attention is being devoted to the improvement of the organizational structures of the management of scientific and technical progress, the organizational forms of the strengthening of the relations of science and practice, and to the methods and technology of the management of scientific and technical progress. An effective organizational structure of the management of scientific and technical progress, which concentrates the

activity of party, soviet, and economic organs on the accomplishment of the most urgent tasks of the intensification of the economy, has been formed.

The goal program method of management has shown itself to advantage in the solution of important problems which are of an intersectorial nature. During the 11th Five-Year Plan enterprises and organizations of the republic took part in the fulfillment of the assignments of more than 160 union programs and implemented 6 republic comprehensive goal programs and 35 republic programs on the solution of the most important scientific and technical problems, as well as more than 200 sectorial and territorial programs.

The introduction and efficient implementation of new organizational forms and methods of the management of scientific and technical progress require the supply of the management system with one of the most important resources of management--timely and reliable information, which characterizes comprehensively the state of the development of science and technology in retrospect, during the current period, and in the future, as well as the influence of this development on the end national economic results. In our republic the republic automated control system of the development of science and technology (the Ukrainian SSR RASUNT) is becoming the basic industrial means of providing the system of the management of scientific and technical progress with information. The Ukrainian SSR RASUNT is a hierarchical multilevel integrated system, which includes intersectorial, sectorial (departmental), territorial, and local levels and is being continuously developed for the purpose of the increase of the quality and efficiency of the management of scientific and technical progress in the republic on the basis of the extensive use of advanced computer hardware and the entire information science industry for the gathering, transmission, storage, accumulation, conversion, and representation of management information.

The integrated automation of the management of the development of science and technology is oriented toward the simulation of its required (planned), actual, and anticipated (forecast) state and the influence of this development on the end national economic results in retrospect, during the current period, and in the future, as well as the making of the data on these states available to all categories of users, including the staff of the directive, intersectorial, sectorial, territorial, and local levels of management. A fundamental feature of the Ukrainian SSR RASUNT is the fact that the bank of data, which are to be simulated in the system, is formed on the basis of state statistical reporting and planning documents, the legal force of which ensures the viability of the RASUNT.

In the Ukrainian SSR RASUNT the following subject areas of the simulation of the development of science and technology and the management complexes, which are equal to them, are distinguished: scientific and technical programs (NTP); the assimilation of the production of new types of industrial products (NVP); the introduction of advanced technology, the mechanization and automation of production processes; the economic impact from the implementation of scientific and technical measures (EEM); the basic indicators of the technical and economic level of production and the most important types of output being produced (TEU); the financing of scientific research work (FNIR); international scientific and technical relations (MNTS);

the introduction of computer technology (VVT); standardization (UST); the introduction of the scientific organization of labor (VNOT); the training of scientists and science teachers (PNK).

A peculiarity of the Ukrainian SSR RASUNT is the digital-to-analog nature of its formation and development on the basis of the goal program method, in conformity with which for each 5-year period specific goals, which follow from the tasks of the socioeconomic development of the republic for the five-year plan, are set for the system and programs of their continuous achievement on the basis of intensive resource-saving technologies of the designing and functioning of the system are formulated.

The implementation of the goal program method of the formation of the Ukrainian SSR RASUNT is accomplished by the setting of the target level of its development and the planned levels of the sections of the system, which are being added gradually. The target level corresponds to such a state of it, given which the system supplies most effectively all the users with adequate information on the required, actual, and anticipated states of the above-listed subject areas of the development of science and technology and its influence on the environment in retrospect, during the current period, and in the future. The target level of development of the Ukrainian SSR RASUNT is specified by the technical assignment on the establishment of the system. Scientific and technical programs, which are sets of measures, which are provided with resources and the implementation of which makes it possible to reduce by the most effective means the difference between the achieved and target levels of development of the system, are being formulated for the achievement of the planned levels of development of the sections of the establishment of the RASUNT. The problems, which are objectively due to the dynamics of the scientific and technical revolution and follow from the tasks posed by directive organs on the acceleration of scientific and technical progress, the improvement of management and the economic mechanism, and the development of automated control systems, are taken into account when formulating the programs, and the priority units, subject areas, and functions of management, which are to be automated, with allowance made for the restrictions on the resources being allocated for the establishment of the specific section of the Ukrainian SSR RASUNT, are distinguished in conformity with this.

The first section of the system as the result of the set of operations, which was performed during the 10th Five-Year Plan and was envisaged by the corresponding scientific and technical program, was put into operation during the 2d quarter of 1980 in the Ukrainian SSR State Planning Committee and the republic Academy of Sciences and was made up of 28 complexes, which unite more than 230 tasks. The choice of the unit of the State Planning Committee (ASUNT-PL) and the Academy of Sciences (ASUNT-AN) as the priority units was due to the decisive role in the management of scientific and technical progress of the Ukrainian SSR State Planning Committee and the Presidium of the republic Academy of Sciences, the former of which is in charge of all scientific and technical activity in the republic, while the latter is in charge of the coordination of basic research in the area of the natural and social sciences.

The development of the system during the 11th Five-Year Plan was carried out in conformity with the union program of the solution of the scientific and technical problem on computer technology, as well as the republic scientific and technical program of the development and introduction of the second section of the Ukrainian SSR RASUNT for 1981-1985. The set of operations, which was performed during the 11th Five-Year Plan with the extensive use of specially developed means of intensification and resource conservation, ensured the placement into operation in 1985 of the second section of the system made up of 33 units, including 4 intersectorial, 23 sectorial, 3 territorial, and 3 local units, which include 84 management complexes, which unite 165 complexes of problems; a distributed database, which includes the databases of 16 units; technological means of the interaction of the units, including in the network mode. Within the intersectorial units 8 subject areas (PO's) of the management of the development of science and technology are encompassed by automation and 45 complexes of problems (KZ's) are operating; within the sectorial units--8 subject areas and 92 complexes of problems; within the territorial units--4 subject areas and 10 complexes of problems; in the local units--6 subject areas and 18 complexes of problems. The automation of the subject areas of the management of scientific and technical programs is most developed--48 complexes of problems, the results of which 21 units are using; the introduction of advanced technology and the mechanization and automation of production processes--48 complexes of problems and 20 units; the economic impact from the implementation of scientific and technical measures--23 complexes of problems and 17 units; the financing of scientific research work--14 complexes of problems and 7 units; the introduction of computer technology--12 complexes of problems and 3 units.

The placement into operation of the indicated facilities created the basis for the integrated automation of the management of scientific and technical activity for the republic as a whole and academic, VUZ, and sectorial science, for the coordination of the sectorial and territorial sections of planning and management, and for the automation of the management of local units (organizations), in which the development of science and technology is directly carried out.

The automation of the management of scientific and technical activity (NTD) encompasses 8 subject areas, with respect to which databases have been formed and more than 30 complexes of problems of their conversion and the supply of the management personnel of the directive, intersectorial, sectorial, territorial, and local levels of management with data have been introduced. Foremost attention has been devoted to the complexes of management, the results of the functioning of which reflect the influence of the development of science and technology on the end national economic indicators. The use of these results ensured the increase of the soundness and quality of the plans of the development of science and technology by means of the more thorough and comprehensive analysis of the actually achieved influence and the variant forecasting of the anticipated influence of the development of science and technology on the national economy on the basis of long-standing (more than 10 years) retrospective statistical information, which is stored in the computer memory, on the expenditures on scientific and technical measures and the economic efficiency from their implementation. The vast analytical material, which is formed by these complexes of management and has been

regularly sent since 1979 to oblast soviet executive committees, ministries, and departments, ensured the objective evaluation of the amounts of work on the increase of the technical level of production--first of all on the introduction of new equipment and the degree of its influence on the increase of labor productivity and on the decrease of the product cost. This enabled the republic State Planning Committee to be one of the first in the country to change over starting in 1981 to the directive planning of the indicators of the decrease of the product cost and the reduction of the number of workers by means of the technical improvement of production, which were envisaged by the decree of the CPSU Central Committee and the USSR Council of Ministers on the improvement of the economic mechanism (1979). Thus, the Ukrainian SSR RASUNT owing to the developed tools of the automation of statistical accounting and analytical forecasting functions was a catalyst of the improvement of the economic mechanism.

The results of the functioning of the Ukrainian SSR RASUNT found application in the process of the making of decisions by republic directive organs for the long-range future. In particular, a number of versions of the expenditures on the implementation of scientific and technical measures and the corresponding indicators of economic efficiency, which ensure in conformity with the decisions of the 27th CPSU Congress and the 27th Ukrainian CP Congress a significant increase of labor productivity by 2000 in the national economy of the republic and the growth of labor productivity due to the introduction of the achievements of science and technology, were determined by the facilities of the RASUNT. For this single- and multiple-criterion mathematical economic models (EMM's) of the optimum choice of measures, which are included in the national economic plan; mathematical economic and information logical models of the coordination of the assignments of the annual and five-year plans; mathematical economic models on the reduction of the use of manual labor in the Ukrainian SSR national economy with a breakdown by the republic as a whole and its oblasts were implemented within the system.

In addition to variant preplanning analytical forecasting guidelines for the short-term and long-term future, in the process of automating the management of scientific and technical activity the formulation of a draft of a plan and a plan on a number of subdivisions of the state plan of the development of science and technology is being carried out by the facilities of the Ukrainian SSR RASUNT.

Within the subject area of scientific and technical programs, which includes the assignments of union republic programs, a draft of a plan and a plan with a breakdown by sectors, departments, and territories and a breakdown by organizations are formulated by the facilities of the RASUNT. The computer formulation of planning documents ensured the coordination of the union and republic programs with the state plan of the republic, as well as owing to the address cross-sections of the plan significantly increased the efficiency and quality of the delivery of the assignments of the programs to the performers. In addition to the formulation of the plan, its multidimensional structural analysis (for the republic as a whole, by sectors, ministries, and departments, types of programs, individual programs, subdivisions, types of assignments, standard stages of their implementation, and others) is carried out on computer. The obtained information enables the end users--the workers

of planning organs--in the process of analyzing programs and formulating the plan to evaluate the uniformity of the distribution of assignments by years and quarters, the intensity of each planning period, and the dynamics of the obtaining of the program products.

In the process of automating the planning of the financing of scientific research work there are determined on computer: the total amount of expenditures on scientific research work with a breakdown by sources of financing; the amount of expenditures on scientific and technical programs and problems in the area of the natural and social sciences with a breakdown by union and republic programs and problems, as well as the amount of expenditures on scientific research work as a percent of the commodity and standard net output; the wage fund and other payments to scientists during the year; the number of scientists and science teachers at scientific institutions, which are located on the territory of the republic as a whole and with a breakdown by oblasts, and others.

The automation of the management of the introduction of computer technology and automated control systems ensured the increase of the balance and soundness of plans, the coordination of the indicators of the drafts of the plans with the approved indicators of the five-year plan, the enlargement of the analytical portion of the calculations and the use of their results when substantiating the drafts of plans, and the variant analysis of their indicators. Here about 30 percent of the indicators of the forms of the annual plan are formed on computer. Within the subject area in question the goal program management of the development of the Ukrainian SSR republic automated control system was automated.

The tracking of the prevailing scientific and technical program of the development of the republic automated control system (the realization of the database of the program in the process of making changes in it, the multidimensional analysis of its structure, the obtaining of a wide range of information on any of the elements of the program, and others), the formulation in an interactive mode of the program of the development of the Ukrainian SSR republic automated control system for the next planning period, and its structural analysis are carried out by the facilities of the Ukrainian SSR RASUNT. At the present stage the automation of the management of the introduction of automated control systems and computer technology is acquiring particular importance in connection with the implementation of the statewide program of the devising, the development of the production, and the efficient use of computer technology and automated systems to 2000.

The complex of the automation of the management of international scientific and technical relations ensures the formulation on computer and the submitting to the State Committee for Science and Technology on magnetic tapes of proposals of the republic Council of Ministers on the annual and 2-month operational plans of foreign assignment, as well as the 2-month operational reporting on foreign assignment and the receiving of foreign scientists and specialists. These documents are accompanied by extensive multidimensional analytical reference information, which is put together on computer. The paperless technology of the comprehensive (from the union to the republic level and back) planning of international scientific and technical relations

and reporting, as well as the coordination of the sectorial and territorial sections of management is implemented by the functioning of this complex.

In the process of automating the management of academic science foremost attention has been devoted to the management of the scientific potential of the Ukrainian SSR Academy of Sciences. For these purposes within the unit of the Academy of Sciences management has been automated within subject areas: "Scientific Institutions," "Thematic Plans of Scientific Research Work," "Scientific Personnel of the Ukrainian SSR Academy of Sciences," "Computer Hardware at the Ukrainian SSR Academy of Sciences," and "New Technologies." The functional complex of forecasting, which has been put into operation and includes the blocks of variant system-goal forecasts, partial and interconnected forecasts, and optimizable forecasts, ensures the forecasting of about 100 different parameters. The results of its functioning found application in the formulation of the comprehensive program of scientific and technical progress and its socioeconomic consequences in the national economy of the Ukrainian SSR to 2000 and 2010.

There were selected as the priority directions of the automation of the management of multisectorial VUZ science: the formulation and the monitoring of the implementation of the plan of research and development (NIOKR), as well as the consideration of the training of scientists and science teachers through graduate studies. The automation of the management of research and development is based on the extensive application of the goal program method of the planning and management of operations, which are performed by higher educational institutions of the Ukrainian SSR Ministry of Higher and Secondary Specialized Education, and is implemented by the introduction of a comprehensive sliding plan of research and development, which encompasses all the stages of the "research-development-introduction" cycle and replaced the thematic plan and plan of introduction, which had been previously adopted at higher educational institutions. The practical orientation of the plan of research and development toward the end result was thereby strengthened significantly. The automation of the management of research and development enables the end users to obtain promptly information on the state of research and development with the required breakdown for the making of the most effective management decisions. The automation of the accounting of the training of scientists and science teachers ensures the preparation of the personnel statistical report and the output of consolidated computer-generated reports, the use of which is oriented toward the making of strategic decisions in the area of the training of personnel of the highest skills.

More than 20 ministries and departments of the republic, which belong to the extractive, processing, and service sectors, the construction sector, the agroindustrial sectors, and others, are encompassed by the automation of the management of the development of sectorial science and technology. In a number of sectorial units planning has been automated on the basis of the unified information-intensive document "The Record Card of Research and Development." The introduction of the system of planning of scientific and technical operations in the unified "science-technology-production" chain in the Ukrainian SSR Ministry of the Timber and Wood Processing Industry on the basis of the supply order created realistic prerequisites for the shortening of the investment cycle of the output of items, the elimination of

unproductive operations, and the changeover to an intensive basis of development. Since the development is standard, a supply order for its introduction in the USSR Ministry of the Timber, Pulp and Paper, and Wood Processing Industry during the current five-year plan has been opened.

The automation of the management of the development of science and technology in the construction sector is oriented toward the increase of the efficiency of the functioning of the "construction science-designing-construction work" system, which is specified by the end users--the increase of labor productivity in construction, the saving of material resources, and the decrease of the product cost. An information logic model, which links the above-named stages of the complete cycle of the development of the construction product and includes passport information of scientific research work, scientific research organizations, designs, and scientific and technical achievements; planning information of republic and sectorial scientific and technical programs, state plans of the development of science and technology in construction, plans of the introduction of scientific and technical achievements through designing, and others, was formed for these purposes. The following operations were performed by the facilities of the Ukrainian SSR RASUNT on the named elements of the information logic model: the draft of the subprogram of the republic scientific and technical comprehensive goal program "The Materials-Output Ratio" for the 12th Five-Year Plan and the annual plan for 1986 on this program were formulated; consolidated plans of the development and introduction of new equipment in construction through designing and the plan of the development of science and technology for the Ukrainian SSR State Committee for Construction Affairs were formulated and defended.

The implementation of the automated technology of the examination of designs ensured the creation of the necessary conditions for the integration of the stages "Designing" and "Construction Work" of the investment cycle in construction, the shortening by 40 percent of the time of the examination of designs, the increase of the amount of examined designs, and the increase of the quality of examination by the formulation of standard decisions and the evaluation of the technical and economic level of design decisions. A computer technology of the management of scientific and technical programs, which made it possible to shorten to two-thirds the time of the formulation of scientific and technical programs and to increase the quality and efficiency of access to information on the programs, is being used for the integration of the stages "research-designing-construction work."

The territorial units of the Ukrainian SSR RASUNT are an effective means of improving the management of the scientific and technical development of the oblasts of the republic. The development of an effective computer technology of the coordination of the territorial, sectorial, and goal program sections of the management of scientific and technical progress is one of the basic goals of their establishment. Within the territorial units the management of the assignments of union and republic scientific and technical comprehensive goal programs, the corresponding regional programs, the decrease of the use of manual labor, the introduction of advanced forms of the organization and stimulation of labor, as well as the formation of the indicators of the section "The Introduction of Science and Technology" of the plan of the

economic and social development of the economy of the oblast has been automated. The results of the functioning of the territorial units are being used by local party, soviet, and economic organs.

There were selected as the priority standard components of the large class of local units in the Ukrainian SSR RASUNT: the academic scientific technical complex (NTK), in which work on the development of automated systems of scientific research (ASNI's) has been developed; the sectorial scientific research institute with developed work in the area of computer-aided design systems (SAPR's); the collective-use computer center (VTsKP) with a developed sector of the science-intensive designing of large-scale automated control systems and a sufficiently large information and computing potential. The activity of the named facilities belongs to the priority areas which determine scientific and technical progress. Within these units the management of manpower, financial, material, and computer resources and scientific and operational activity has been automated.

In our republic during the current five-year plan the increase of labor productivity by more than 20 percent, which will make it possible to save the labor of 3.6 million people, should become the main factor of economic growth. For this decisions on the cardinal transformation of physical production on the basis of the acceleration of scientific and technical progress, the expansion of renovation and the replacement of fixed capital, the increase of the quality of products and operations, and the utmost saving of resources were made when formulating the plans for each sector, oblast, and the republic as a whole. Particular attention in the plan is devoted to steps on the acceleration of scientific and technical progress and the assurance on this basis of the significant increase of the qualitative indicators of the growth of production efficiency. Specific assignments on the achievement of a high success rate in the use of new equipment and technology have been established for ministries and departments, the goal orientation of the scientific and technical measures being implemented has been strengthened. In industry alone the economic impact from their implementation should exceed on the average 1 billion rubles a year.

Republic scientific and technical goal programs, which are oriented toward the priority directions of scientific and technical progress, are the organizing basis of the plan of the introduction of new equipment. Here the task of the close coordination of the programs with the plans, the complete supply of the programs with the necessary resources, and the increase as compared with the 11th Five-Year Plan of the economic impact from their implementation by not less than twofold is being posed.

It is planned to implement six republic scientific and technical goal programs--"The Materials-Output Ratio," "Metal," "The Energy Complex," "The Agricultural Complex," "Transport," and "Labor," the scientific program "Biotechnology," 170 regional programs, and 120 sectorial programs. Their implementation should play a decisive role in the fulfillment of the tasks on the saving of resources, which face the republic during the 12th Five-Year Plan. The main one of them is to meet 75-80 percent of the increase of the need of the national economy for fuel, raw materials, and materials by their saving.

During the current five-year plan the cooperation of science with production has to be strengthened and the dissemination of such advanced forms of it as engineering centers, interbranch scientific technical complexes, and scientific production associations, which are called upon to ensure the rapid and large-scale introduction of the achievements of science and technology in production and the obtaining of a large economic impact, has to be expanded.

The reform of the economic mechanism, which is being carried out in the republic, presumes the further increase of the efficiency of the system of the management of scientific and technical progress. There should be made the basis of this system: the comprehensive system of the planning of scientific and technical progress, which unites into a unified whole both the economic analysis, forecasting, long-range and current planning of the development of science and technology and the sectorial, regional, and goal program sections of the plan at all levels and in all units of management; the intensification of the integration of science and production; the increase of the efficiency of the implementation of the goal program method. This requires the cardinal improvement of the technology of information processes, which is based on advanced computer hardware, integrated databases, and data processing and transmission networks. Interactive means of the simulation and analysis of the operating information mechanism of the management of the development of science and technology for its continuous improvement, as well as the automation of the functions of management of the new, improved mechanism are its natural components.

The analysis of the information mechanism of management at the same time as the systems engineering result--the construction of a model of the object of automation--provides means of the scientifically sound formation of a set of economic indicators of the management of the development of science and technology. Therefore, the model of the mechanism of management is fruitful not only for the formation and development of the RASUNT proper, but also for the elaboration of a number of theoretical problems of economics: in particular, it makes it possible to extend and specify the understanding of such basic economic categories as "goal," "problem," "the manageability of the development of science and technology" with respect to the goals, the yield, and the state, "the program product and its special-purpose properties," "utility," "efficiency," "socially necessary expenditures of labor," and others.

Assignments on the further intensive increase of the level of comprehensiveness of the automation of the management of the development of science and technology by the inclusion in the elaboration on the basis of large-scale introduction of standard design decisions of new sectorial and territorial units of the system is envisaged during the current five-year plan by the scientific and technical program of the development of the Ukrainian SSR RASUNT. Here it is planned to develop the units, which were previously placed into operation, into integrated units, that is, units which ensure the interaction of the automated systems, which serve the staff of ministries (departments), as well as the organizations subordinate to them with allowance for the establishment in them of automated systems of scientific research and computer-aided design systems. The accomplishment of these assignments of the

program is directly oriented toward the shortening of the investment cycle of the development of new equipment and technologies and the acceleration and broadening of the scale of the introduction of the achievements of science and technology in practice.

The development of an integrated database on scientific and technical progress, as well as the development and introduction in 1988 with its use of a subsystem of the computer-aided formulation, adjustment, and analysis of republic scientific and technical programs are envisaged by the program of the development of the Ukrainian SSR RASUNT for the increase of the success rate of the goal program methods of the management of scientific and technical progress. The development of this subsystem is oriented toward the increase of the quality and efficiency of republic programs by the optimization of the choice of problems for program elaboration, based on the goals of the acceleration of socioeconomic development, the strengthening of the problem orientation of the assignments of the programs, the optimization of the distribution of resources for the implementation of programs and their assignments, and the optimization of the appointment of the main performers and coperformers of the programs, assignments, and stages of their implementation. Moreover, it is envisaged by the development of the subsystem to increase the efficiency of the technology of the formulation of programs and to reduce the labor intensiveness and time of their formulation by means of the standardization of the content components of the programs and the automation on this basis of the elaboration of the texts of the assignments of the programs and the stages of their implementation in the interactive mode.

The increase of the success rate of the goal program methods involves not only the optimization and automation of the formulation of the programs, but also the analysis and evaluation of their efficiency in the process of formulation and implementation, the coordination of the programs with the plans, the timely delivery of the assignments of the programs to the performers, and the tracking and monitoring of the fulfillment of the programs. Thus, the increase of the success rate of the republic programs is a complex problem, which requires for its solution the uniting of the efforts of managers, workers of planning organs, scientists, and specialists in the areas of economics, cybernetics, and scientific and technical information, as well as specialists in the subject areas which are equal to the content of the programs being formulated. For this purpose assignments for the Scientific Research Institute of Economics of the Ukrainian SSR State Planning Committee on the elaboration of procedural instructions on the making of an analysis and evaluation of the efficiency of scientific and technical programs and the preparation of proposals on the further improvement of the goal program methods of planning and management; assignments for the Ukrainian Scientific Research Institute of Scientific and Technical Information and Technical and Economic Research and its intersectorial territorial centers on the tracking and monitoring of the fulfillment of republic scientific and technical programs; assignments for the main (leading) scientific research organizations for the most important republic programs on the coordination and scientific methods supervision of programs and the tightening up of the monitoring of the high-quality and timely fulfillment of the assignments of the programs; assignments for Ukrainian SSR ministries and departments on the making of an annual analysis of the success rate of scientific and technical programs are

envisioned by the program of the development of the Ukrainian SSR RASUNT. The accomplishment of these assignments with the extensive use of the computer technology of the Ukrainian SSR RASUNT is a fundamentally important step in the increase of the success rate of scientific and technical programs.

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SCIENTIFIC, TECHNICAL PROGRESS IN PARTY ECONOMIC STRATEGY

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[Article by Doctor of Economic Sciences Professor M. Chernenko under the rubric "The Development of Economic Theory in the Materials of the 27th CPSU Congress" (Kiev): "The Cardinal Acceleration of Scientific and Technical Progress Is a Vital Issue of the Economic Strategy of the CPSU"; passages within slantlines published in italics]

[Text] The questions of scientific and technical progress hold an extremely important place in the economic strategy of the party, which was formulated by the 27th congress and is aimed at the profound qualitative transformation of all aspects of life of Soviet society by the socioeconomic acceleration of its development. The acceleration of socioeconomic development, it was noted in the Policy Report of the CPSU Central Committee, implies "first of all the increase of the pace of economic growth. But not only that. Its essence lies in a new quality of growth: the utmost intensification of production on the basis of scientific and technical progress...."(1) In light of the concept of the acceleration of the socioeconomic development of the country the question of the pace of economic growth is acquiring particular importance and a new content. The economy of our country has risen to such a level, when it can and should be developed rapidly on the basis of the comprehensive and consistent intensification of production. /The main means of its accomplishment is the cardinal acceleration of scientific and technical progress and the achievement of the highest levels of science and technology./⁽²⁾ These theoretical theses, which were advanced by the 27th CPSU Congress, enrich the economic teaching of Marxism-Leninism on the dialectical unity and interaction of productive forces and production relations under the conditions of the intensification of the scientific and technical revolution, which is having a mighty influence on all aspects of modern production and on the entire system of production relations of socialism.

The policy of the acceleration of the socioeconomic development of the country is precisely such a most important socioeconomic, scientific, and technical transformation, which appears as a change of one quality into another, which occurs in the process of overcoming contradictions, which "gives the key to 'self-propulsion'...and the key to 'the discontinuation of gradualness'."⁽³⁾

The constant improvement of production relations, the maintenance of their stable conformity to the dynamically developing productive forces, and the timely identification and resolution of the nonantagonistic contradictions, which emerge between them, are a prerequisite of the acceleration of the socioeconomic progress of society.

The conversion of quantitative changes into qualitative changes holds an important place in the interaction of productive forces and production relations.(4) In light of this the principles, which were formulated in documents of the CPSU /on the two forms of scientific and technical progress: evolutionary and revolutionary/(5) and on the intensification of the scientific and technical revolution and the new stage of its development,(6) are fundamentally new theoretical generalizations. In this connection, in our opinion, it is necessary to establish the relationship of scientific and technical progress and the scientific and technical revolution.

As was noted above, scientific and technical progress occurs in both a gradual evolutionary and an abrupt revolutionary form. The gradual changes in the development of science and technology, discoveries, inventions, and so forth with time accumulate and develop from quantitative into qualitative ones and from evolutionary into revolutionary ones, which are characterized by unique leaps and real radical changes in scientific and technical development. Mankind is now going through such a qualitative leap in science and technology, which is unprecedented in its scale, pace, and consequences--the scientific and technical revolution. The scientific and technical revolution, which began in the middle of the 20th century, is such a radical change, such a cardinal transformation in productive forces under the influence of the rapid development of science and technology, "which sweeps away the old in a most basic and radical manner, but does not alter it cautiously, slowly, gradually...."(7)

The definition of the scientific and technical revolution /as a modern form of scientific and technical progress/, which stems from social needs and the level of development of large-scale mechanized production,(8) is most widespread. When speaking, however, about "form," one should bear in mind that this is a multilevel and multidimensional category, which characterizes various levels of development of the content. Under present conditions the scientific and technical revolution acts as a higher form(9) of scientific and technical progress, which forms on the basis of new trends in the long-range development of science and technology, which encompass a lengthy period of time. At the 27th CPSU Congress it was emphasized that the 15-year horizon of the socioeconomic development of the USSR is the optimum period, during which the achievements of the present stage of the scientific and technical revolution with allowance made for the forecasts of its development can be fully utilized.(10)

The launching of scientific research, "which affords new possibilities for major, revolutionary changes in the intensification of the economy,"(11) is one of the most important traits of the present stage of the scientific and technical revolution. More than 100 years ago K. Marx discovered the law of the transformation of science into an immediate productive force and regarded science as "a historically motive, revolutionary force," a revolutionary force

in the highest meaning of this word.(12) But this revolutionary role of science, which was brilliantly predicted by K. Marx, is properly revealed only under the conditions of the scientific and technical revolution. Now it is simply impossible to accomplish the rapid growth of social production without extensively developed scientific research and its rapid and massive application in practice. In order to transform the production process "from a simple process of labor into a scientific process,"(13) science should be a continuous generator of ideas and look into the unknown, "beyond the horizon." While precisely this also gives the entire scientific and technical revolution a strategic role in the scientific and technical development of modern society.

Inasmuch as form is in inseparable unity with content, it cannot but affect by way of feedback this content--scientific and technical progress itself. The evolutionary form under present conditions is beginning to hamper scientific and technical progress. At the April (1985) CPSU Central Committee Plenum it was noted that "in the majority of sectors scientific and technical progress is proceeding sluggishly, in reality in an evolutionary manner--primarily by the improvement of existing technologies and the partial modernization of machines and equipment. Of course, these steps are yielding a definite return, but it is too little. Revolutionary changes are needed--the changeover to fundamentally new technological systems and to equipment of the latest generations, which provide the greatest efficiency. It is essentially a question of the retooling of all the sectors of the national economy on the basis of advanced achievements of science and technology."(14) Consequently, the extensive use of the achievements of scientific and technical progress on the basis of revolutionary changes and cardinal qualitative transformations in production is necessary for the implementation of the policy of the acceleration of the socioeconomic development of the country. "The national economy should be reorganized in a flexible and timely manner in conformity with the advanced changes in science, equipment, and technology and in social and individual needs. It is necessary to develop more rapidly the sectors which support scientific and technical progress," it is noted in the CPSU Program.(15)

First of all this pertains to the development of both basic and applied research and experimental design development.(16) For the contact of science with production is achieved precisely in these spheres of scientific activity. It is also no secret that the shift from scientific ideas and models of equipment to their mass assimilation in production is the narrowest link in this connection. Hence the need for revolutionary changes and a truly revolutionary form of scientific and technical progress, which provides the most favorable conditions for the use in production of the achievements of the scientific and technical revolution. This form of scientific and technical progress expresses such contacts, which occur in its content and realize the final stage of the materialization of scientific knowledge. The most advanced scientific and technical ideas may remain unimplemented, if the actual acceleration of scientific and technical development, which is understood not only as the speeding up of its pace, but also as the provision of the necessary conditions in production for the most efficient introduction of the ideas of the scientific and technical revolution, is not ensured.

For the achievement of the new technical modernization of the national economy and the creation of the prerequisites of the acceleration of scientific and technical progress the Communist Party with full adherence to principles is posing the question of /the sharp change of investment and structural policy/. In the new version of the CPSU Program the task is posed "to shift the center of gravity from new construction to the retooling and modernization of operating enterprises, to raise significantly the share of assets being allocated for these purposes in the total amount of productive capital investments, to increase in them the proportion of expenditures on equipment and machines."(17)

The shortcomings of the past investment policy affected most of all the development of machine building and appeared in the decrease of the technical level of its sectors and product quality. When developing new equipment the level of quality and reliability in practice was not taken into account, in essence a systems analysis of the latest world achievements was lacking. Thus, for example, only 29 percent of the series-produced industrial products conform to the world level.(18) A faulty philosophy of imitation and mediocrity, which led to the lack of conformity of a portion of the products to the present level of science and technology, formed due to such miscalculations.(19)

In this connection our party has outlined a number of cardinal steps on the further development of machine building. During the 12th Five-Year Plan there will be a 1.8-fold increase of the capital investments in the machine building complex--"the complex, in which the achievements of scientific and technical progress are materialized. Particular emphasis is being placed on the development of those sectors of it, which ensure qualitative changes in the technical level of machine building itself. /The material basis of the acceleration of scientific and technical progress/ is formed by this."(20) Suggestions on additional steps of the acceleration of the development of machine building, which will make it possible to increase by 1990 the proportion of products of the basic products list, which conform to the world level, to 80-95 percent and that of products being newly developed to practically 100 percent, have been prepared on the instructions of the CPSU Central Committee. It is planned to accomplish in full the changeover to the output of items at the level of the highest demands during 1991-1993.(21) Such tasks are being posed for the first time.

The orientation toward the surpassing of world achievements should become one of the important principles of the work of all ministries, associations, and enterprises.

The 27th CPSU Congress in specifying the policy of comprehensive intensification proceeded from the analysis of the enormous possibilities of the present stage of the scientific and technical revolution. This stage is characterized by: a rapid pace of the development of science and technology; the interaction of science and technology; "breakthroughs" into new fields of human knowledge.(22) In the opinion of scientists, this stage is characterized by the extensive introduction of microprocessor equipment and by the development of biotechnology.(23) It is necessary to carry out the acceleration of scientific and technical progress on the basis of new

directions of the scientific and technical revolution with allowance made for the joint development and efficient use of scientific and technical achievements of the countries of the entire socialist community and active participation in the world division of labor. Five priority directions, which were formulated on the basis of the generalization of both domestic and world experience, as well as the results of joint scientific and technical forecasting: the electronization of the national economy; integrated automation; atomic energy; new materials and the technology of their production and processing; biotechnology, are distinguished in the Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries to 2000.(24) The acceleration of scientific and technical progress in the USSR, as in the other socialist countries, is based first of all on the rapid development of the indicated directions, which are the basis for advanced revolutionary changes in science, technology, and production. These directions of scientific and technical progress conform to the task posed in the CPSU Program: "...to conclude complete mechanization in all the sectors of the production and nonproduction spheres, to take a major step in the automation of production with the changeover to automated shops and enterprises, automated control systems, and computer-aided design systems."(25)

Microelectronics, computer technology and instrument making, and the entire information science industry, which are having a decisive influence on the efficiency of means of labor and on the development of the integrated automation of production, are the catalysts of modern scientific and technical progress.

The technical revolution in computer technology, which led to a new stage of the scientific and technical revolution, to a significant extent was due to the production of an enormous number of microprocessors.(26)

A statewide program of the development of the production and the efficient use of computer hardware and automated systems for the period to 2000 has been formulated for the purpose of the further development of electronics in our country. The development and assimilation of new generations of computers of all classes from supercomputers to personal computers for school instruction are envisaged during the 12th Five-Year Plan. It is planned to produce 2.4-fold more computer hardware than during the preceding five-year plan, including 1.1 million personal computers. This will make it possible to increase the proportion of machines and equipment, which are furnished with electronic means of control, including microprocessors, in the total output of products of machine building from 5 percent in 1985 to 27-32 percent in 1990, and with respect to several of their most important types to 70 percent.(27) The level of automation on the average for the national economy will increase by twofold.(28) During 1986-1990 the output of machining centers will increase by 4.3-fold; flexible automated systems (complexes)--threefold; flexible modules--2.8-fold; industrial robots--2.2-fold; NC machine tools--1.9-fold; microprocessor means of regulation for control systems of technological processes--tenfold.(29)

Up to now several types of advanced equipment are still being used separately with respect to individual production processes, although their use in the

form of flexible machine systems (GAP's) is most effective. NC machine tools, machine tools like the "machining center," robots, automatic transportation, and automated warehouses, as well as computer hardware are used jointly in flexible machine systems. In the USSR 193 flexible machine systems were introduced in 1985 alone. While by the end of the 12th Five-Year Plan about 2,000 of them will have been created.(30)

Microelectronics and the computers, which have been developed on its basis, hold the central place in the system of elements of flexible machine systems. The configuration (architecture) of computer systems has changed fundamentally in connection with the development of microprocessors. The traditional large computer center is now being supplemented with a large number of small, inexpensive, and reliable microcomputers, which are placed directly on the component assemblies and parts of machinery with the local control of each object. Thus, the microcomputer is becoming an important connecting link which creates the possibility of giving automation an integrated comprehensive nature.

Flexible machine systems are the highest form of automation for series production with a large and frequently changing range of items, that is, quickly readjustable production. Let us note that mass production in machine building takes up in the volume of output only one-fourth, the remaining three-fourths of the items are produced under the conditions of series, small-series, and custom production.(31)

Under present conditions production automation is rising to a qualitatively higher level of its development, which involves not only automation, but also the control of technological processes on the basis of automated control systems (ASU's). In the 1970's primarily automated control systems for economic organizational purposes were created. In recent times plant technical management automation systems (ASUTP's) have undergone intensive development. During 1981-1985 more than 3,000 automated control systems, including about 3,000 plant technical management automation systems, were created in the USSR.(32)

There is every reason to believe that the implementation of various automated data processing systems for the management and planning of large spheres and the entire national economy on the basis of the principles of the organizational and technical unity of the integrated system of the functioning of automated control systems of central statewide organs of the USSR State Planning Committee, the USSR State Committee for Material and Technical Supply, the USSR Central Statistical Administration, and others is becoming possible.

The placement into operation of the first sections of the automated control systems of planning calculations, state statistics, and scientific and technical progress and a number of other intersectorial automated control systems made it possible to shorten the time of the formulation and coordination of plan assignments and to make the optimum decisions. Now automated control systems attend the production of more than half of the industrial output, over 30 percent of the large industrial enterprises are equipped with them.(33) The first sections of republic automated control

systems have been created in a number of union republics. The making of a shift from a three-level to a four-level computer complex and the expansion of integrated production automation will be of enormous importance for the creation of the material prerequisites of the strengthening of the fundamental connection of mental and physical labor.

/The humanistic orientation of scientific and technical progress under socialism/ is being opposed by its antagonistically contradictory development under capitalism. It is assumed that by the end of the 20th century the amount of scientific knowledge will increase by twofold, while the flow of information will increase by more than thirtyfold. Computers should play a decisive role in the processing of this information, which is increasing like an avalanche. For example, in the United States the "microprocessor revolution" will change the nature of labor of about 50 million workers and employees. By 2000, 80 percent of all the manual operations will be automated here. As a result not less than 40 million workers will turn out to be unnecessary.(34) In this connection the bourgeois concepts of the future "information society," "scientific capitalism," and so forth are becoming widespread. American bourgeois sociologist D. Bell believes that "with the decrease of working time and the elimination of the production worker, who, according to Marx, is the source of value...it is becoming clear that knowledge and its application are replacing the worker as the source of 'surplus value in the national income'." In this sense information and knowledge are the basic variables of postindustrial society, in much the same way as capital and labor became the main variables of industrial society.(35) Thus, D. Bell attempts to use the increase of the role of mental, scientific labor under the conditions of the scientific and technical revolution to deny the theory of labor value and the exploitation of workers under capitalism.

Under the conditions of the developing scientific and technical revolution the role of science in the scientific and technical functioning of production, the rapid development of which without science is now simply impossible, is increasing under socialism. Therefore, the problems of the development of science should be solved through the prism of the requirements of the times--the requirements of its resolute turn toward the needs of social production, and of production toward science. All the links of the chain, which unite science, technology, and production, should be analyzed and strengthened from this standpoint.

"A vital task of science," it is indicated in the Basic Directions of USSR Economic and Social Development for 1986-1990 and the Period to 2000, "is to strengthen the contact of science and production, to develop such organizational forms of the integration of science, technology, and production, which make it possible to ensure the prompt and quick passage of scientific ideas from conception to extensive application in practice. To increase the responsibility of scientific organizations for the level of research and development, for their more complete use."(36)

The basic directions, which are called upon to ensure the strengthening of the contact of science with production, are: the further development of academic science and the increase of the role of the USSR Academy of Sciences in the organization of the entire system of scientific research; the intensification

of the activity of sectorial scientific and planning and design organizations; the development of so-called plant science; the establishment of scientific production associations; the expansion of scientific research at higher educational institutions, and so on.

The heart of the domestic scientific potential is the USSR Academy of Sciences, where the most skilled scientists are concentrated. The organization within the USSR Academy of Sciences of such a new form of the integration of science with production as interbranch scientific technical complexes (MNTK's) following the experience of the Institute of Electric Welding imeni Ye.O. Paton of the Ukrainian SSR Academy of Sciences and other scientific institutions is very effective. Such complexes are becoming the main organizations, which coordinate basic research in the most important intersectorial scientific and technical directions. The interbranch scientific technical complexes of the USSR Academy of Sciences hold a leading place in the country in specific scientific and technical directions which have large research reserves. A significant potential of scientists and engineering and technical personnel, who have the necessary training and experience in solving important scientific and technical problems, is concentrated at them.

The establishment in the system of the Ukrainian SSR Academy of Sciences of eight engineering centers, which ensure the effective contact of academic science with production, is arousing interest. Within such centers there are divisions of design and technological bureaus, which work in close contact with institutes and implement their own developments at pilot works. The functioning of these centers made it possible to shorten to one-half the time of the introduction of completed developments and to reduce it on the average to 2 years.(37) The experience of the integration of science with production, which was gained in the Ukrainian SSR, received a positive evaluation at the conference in the CPSU Central Committee on questions of the acceleration of scientific and technical progress and continues to be improved.

Significant reserves of the integration of science with production are incorporated in the development of sectorial science (sectorial scientific research and technical institutions). However, a serious drawback of sectorial science--isolation from production needs--should be noted. It is important to place the work of sectorial scientific research institutes on a scientific basis, to strengthen the planning element at them, and to change over to the path of intensification. It is advisable, as was noted at the conference in the CPSU Central Committee on questions of the acceleration of scientific and technical progress, to include sectorial scientific research institutes within scientific production or production associations, having strengthened thereby the plant sector of science. The joint work of scientists and research engineers in production will increase their contribution to the improvement of technological processes and to the increase of production efficiency.

An important role in strengthening the contact of science with production belongs to higher educational institutions--an enormous scientific potential of our country. At the present stage they, in our opinion, are performing an amount of scientific work, which does not correspond to the available

potential. Higher educational institutions can increase the amount of scientific research work by 2- to 2.5-fold.(38) Life dictates the need to increase the efficiency of the use of this potential and to eliminate the departmental isolation between research institutions, higher educational institutions, and production.

The implementation of the reform of higher and secondary specialized education is an important reserve of the increase of the efficiency of VUZ science. The task of substantially broadening the scale of the scientific research work of higher educational institutions, for which it is proposed to revise the structure of the distribution of manpower, financial, and material resources and to channel them first of all into the concluding stage of the "research-development-introduction" cycle, is posed in the draft of the CPSU Central Committee of "The Basic Directions of the Reform of Higher and Secondary Specialized Education in the Country." If the amount of basic research increases by twofold, the amount of design and technological research and pilot experimental research will increase by approximately three- to fourfold. For the purpose of solving large-scale socioeconomic, scientific, and technical problems cost accounting operations between higher educational institutions and production associations and enterprises will also be further developed.(39)

/Scientific and technical progress is playing a decisive role in the increase of labor productivity./ The attainment by the USSR of the highest world level of the productivity of national labor should become the most concentrated expression of the scientific and technical modernization of production. This task holds one of the central places in the program of the acceleration of the socioeconomic development of the country and the qualitative transformation of its material and technical base, which was formulated by the CPSU. In the new version of the CPSU Program there is envisaged as an important milestone on the way to the highest labor productivity its increase during the next 15 years by 2.3- to 2.5-fold.(40) It is envisaged already during the 12th Five-Year Plan to increase labor productivity as a whole for the national economy by 23 percent, including by 25 percent in industry,(41) moreover, two-thirds of the increase of labor productivity in industry will be provided by means of scientific and technical progress.(42) The radical transformation of the material and technical base will make it possible during the current five-year plan for the first time in history to achieve an increase of physical production practically without the attraction of additional manpower and to channel its entire increase (3.2 million people) into the nonproduction sphere. Without the planned increase of labor productivity the USSR national economy would additionally need more than 22 million workers. By 2000 the proportion of manual labor should be reduced to less than one-half. This will make it possible to free from unskilled work more than 20 million people, including more than 5 million during the 12th Five-Year Plan, which is more than twofold more than during the past five-year plan. The positive example of the workers of Zaporozhye Oblast, who were able in 3 years to decrease the number of people employed in manual labor in industry by 9 percent and in construction by 15 percent, was pointed out at the 27th party congress.(43) This can also be achieved in other oblasts, krays, and republics.

Much attention at the 27th CPSU Congress was devoted to /the role of scientific and technical progress in the saving of resources/--material (especially natural) and manpower. K. Marx wrote that "effective economy--saving--consists in the saving of working time...this saving is identical to the development of the productive force."(44) This thesis is becoming especially urgent in connection with the task, which was posed by the 27th party congress, /to turn economy into the basic source of the meeting of the additional needs for fuel, raw materials, and other materials/. In the next 5 years by means of this it is planned to meet 60-65 percent of the increase of the need for the most important resources. As a result the saving of material expenditures for the national economy of the country in 1990 should double.(45) The country has not yet known such a scale of resource conservation. And the CPSU named the extensive use of the latest equipment and technology as the first among the diverse means of solving the problem of resource conservation. The implementation of the set of scientific and technical measures in the area of the saving of resources should yield during the 5-year period a decrease of the cost of USSR industrial output by 28.6 billion rubles as against 16.3 billion rubles during the past five-year plan.(46)

It has been demonstrated theoretically and practically that the investment of physical assets in the development of science and technology yields a significant economic impact and quickly pays for itself. During 1981-1984 an economic impact of 19.7 billion rubles was obtained as a result of the introduction of new equipment in USSR industry and an economic impact of 28.3 billion rubles was obtained as a result of the use of inventions and efficiency proposals in the national economy.(47) These figures are quite impressive. However, it is unquestionable that the impact would have been more significant, had it not been for the existing barriers in the economic mechanism, which check the introduction of the latest achievements of science and technology and decreased the receptivity of the economy to scientific and technical progress. Not partial improvements, but the cardinal reform of the economic mechanism is necessary in this matter. "The task is to form an integrated system of management, which completely conforms to the intensive type of economic growth and affords the maximum freedom for scientific and technical progress...."(48) It is necessary to see to it that the fulfillment of the plan assignments would be possible only on the condition of the constant scientific and technical modernization of production, that the plan of the introduction of new equipment would not be opposed to the production plan, while the advanced drafting of plans of scientific and technical progress would be made the basis for the determination of the indicators of economic and social development. At the June (1986) CPSU Central Committee Plenum it was noted that the further strengthening of both elements of democratic centralism will be necessary for this. "On the one hand, we should strengthen further the centralized elements in the management of the national economy, increase the role of the State Planning Committee and other economic departments, and specify the functions of ministries. And, on the other, we should broaden rights and economic independence in every possible way and increase the responsibility of enterprises and associations for the results of their activity."(49) The new methods of management, which have been tested during economic experiments in industry, should be introduced more extensively and rapidly in practice.

FOOTNOTES

1. "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza" [Materials of the 27th Congress of the Communist Party of the Soviet Union], Moscow, 1986, p 21.
2. Ibid., pp 228-229.
3. V.I. Lenin, "Poln. sobr. soch." [Complete Works], Vol 29, pp 110, 317.
4. V.I. Lenin noted: "...a change, which appears as purely quantitative, also turns into a qualitative one" (V.I. Lenin, "Poln. sobr. soch.," Vol 29, p 110).
5. See "Materialy Plenuma TsK KPSS 23 aprelya 1985 goda" [Materials of the CPSU Central Committee Plenum of 23 April 1985], Moscow, 1985, p 10.
6. See "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," pp 24, 141, 227.
7. V.I. Lenin, "Poln. sobr. soch.," Vol 44, p 222.
8. See "Ekonomicheskaya entsiklopediya. Politicheskaya ekonomiya" [An Economic Encyclopedia. Political Economy], Vol 3, Moscow, 1979, p 40.
9. See K. Marx and F. Engels, "Soch." [Works], 2d edition, Vol 46, Part I, p 324; V.I. Lenin, "Poln. sobr. soch.," Vol 27, p 376.
10. See "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," p 227.
11. Ibid., p 142.
12. K. Marx and F. Engels, "Soch.," 2d edition, Vol 19, pp 348-349, 351.
13. K. Marx and F. Engels, "Soch.," 2d edition, Vol 46, Part II, p 208.
14. "Materialy Plenuma TsK KPSS 23 aprelya 1985 goda," p 10.
15. "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," p 143.
16. Thus, for example, in 1980 the ratio of the expenditures on basic research, applied research, and development in all the expenditures on science came in the USSR to: 13, 64, and 23 percent, and in the United States respectively 13.7, 23.4, and 62.9 percent (see "Ekonomika i organizatsiya sotsialisticheskogo proizvodstva, strategiya yego effektivnogo razvitiya" [The Economics and Organization of Socialist Production and the Strategy of Its Effective Development], Vol I, Moscow, 1981, p 133; IZVESTIYA AN SSSR. SERIYA EKONOMICHESKAYA, No 1, 1981, p 121). These data show that given a practically identical proportion of

expenditures on basic research the share of applied research in the USSR is greater, while the share of development is ten twenty-sevenths as great as in the United States. And although it is impossible not to consider that the ratio of the expenditures on science in the United States reflects the spontaneous market mechanism of the pursuit by capitalists of the quickest derivation of a profit, nevertheless, apparently, it should be noted that the share of the expenditures on development in our country is obviously inadequate.

17. "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," pp 143-144.
18. See: N.I. Ryzhkov, "O Gosudarstvennom plane ekonomicheskogo i sotsialnogo razvitiya SSSR na 1986-1990 gody" [On the State Plan of USSR Economic and Social Development for 1986-1990], Moscow, 1986, p 17.
19. See "Materialy Plenuma Tsentralnogo Komiteta KPSS 16 iyunya 1986 goda" [Materials of the CPSU Central Committee Plenum of 16 June 1986], Moscow, 1986, p 17.
20. "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," p 241 (the italics are mine--M.Ch.).
21. See "Materialy Plenuma Tsentralnogo Kommiteta KPSS 16 iyunya 1986 goda," p 25.
22. See PRAVDA, 18 December 1985.
23. On this see, for example: A.A. Dynkin, "Economic Problems of Scientific and Technical Progress in the Capitalist Countries," MIROVAYA EKONOMIKA I MEZHDUNARODNNYE OTNOSHENIYA, No 7, 1985; Yu.V. Yakovets, "Zakonomernosti nauchno-tehnicheskogo progressa i ikh planomernoje ispolzovaniye" [The Laws of Scientific and Technical Progress and Their Systematic Use], Moscow, 1984.
24. See "Kompleksnaya programma nauchno-tehnicheskogo progressa stran-chlenov SEV do 2000 goda. Osnovnyye napravleniya" [The Comprehensive Program of Scientific and Technical Progress of the CEMA Member Countries to 2000. The Basic Directions], Moscow, 1986, pp 2, 6.
25. "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," pp 141-142.
26. Thus, according to hypothetical data, the number of personal computers will increase from 250,000 in 1982 to 2.5 million in 1990 (see KOMMUNIST, No 6, 1986, p 96).
27. See: N.I. Ryzhkov, "O Gosudarstvennom plane ekonomicheskogo i sotsialnogo razvitiya SSSR na 1986-1990 gody," p 16.
28. See "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," p 237.

29. See: N.I. Ryzhkov, "O Gosudarstvennom plane ekonomicheskogo i sotsialnogo razvitiya SSSR na 1986-1990 gody," p 15.
30. See PRAVDA, 26 January 1986; POLITICHESKOYE SAMOOBRAZOVANIYE, No 7, 1986, p 127.
31. Calculated according to "SSSR v tsifrakh v 1985 g." [The USSR in Figures in 1985], Moscow, 1986, pp 79-80.
33. See ARGUMENTY I FAKTY, No 5, 1985, p 7.
34. See "Scientific and Technical Achievements in the Service of Peace and Progress," KOMMUNIST, No 6, 1986, pp 94-96.
35. "The Computer Age: A Twenty-Year View," Washington, 1981, p 168.
36. "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," p 281.
37. See PRAVDA UKRAINY, 6 August 1985.
38. See: M.S. Gorbachev, "Korennoy vopros ekonomicheskoy politiki partii" [A Vital Question of Party Economic Policy], Moscow, 1985, p 20.
39. See PRAVDA, 1 June 1986.
40. See "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," p 142.
41. See: N.I. Ryzhkov, "O Gosudarstvennom plane ekonomicheskogo i sotsialnogo razvitiya SSSR na 1986-1990 gody," pp 11, 57.
42. See "Materialy XXVII syezda Kommunisticheskoy partii Sovetskogo Soyuza," p 280.
43. "Materialy Plenuma Tsentralnogo Komiteta KPSS 16 iyunya 1986 goda," p 32.

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PRODUCT QUALITY, SCIENTIFIC, TECHNICAL PROGRESS

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[Article by Doctor of Technical Sciences N.A. Yevstropov, dean of a faculty, Candidate of Technical Sciences I.G. Leonov, deputy dean of a faculty, and Candidate of Technical Sciences A.M. Dobrovolskaya, docent, the All-Union Institute of Construction Materials, under the rubric "Universal Education in Quality": "Lecture 2. Product Quality and Scientific and Technical Progress"; second in a series of articles; for the first article, see the preceding item]

[Text] The Basic Directions of the Acceleration of Scientific and Technical Progress and the Development of Science

In many respects the achievement of the goals set by the 27th CPSU Congress depends on how quickly the shift to intensive factors of economic growth is accomplished and how completely plans of the modernization of the national economy on the basis of the latest achievements of science and technology are implemented.

It is necessary to begin such modernization first of all with the change of structural and investment policy. Its reform envisages the redistribution of capital investments in favor of machine building sectors. Compared with the 11th Five-Year Plan these investments are being increased by 1.8- to 2-fold. The radical modernization of machine building will be accomplished on the basis of the leading development of machine tool building and instrument making, the electrical equipment and electronics industry, and the production of computer hardware; the growth rate of the output of products in these sectors will be 1.3- to 1.6-fold greater as compared with the average for machine building.

Machine building is also currently acquiring decisive significance because all the urgent problems of the economy today are essentially focused in it. And this is not by chance. The system of large-scale mechanized production, while being spread in breadth, is also being introduced, in addition to industry, in other sectors of physical production. Thus, the use of machine systems and the achievements of biotechnology and genetic and cellular engineering in agriculture is creating conditions, under which the opposition of agrarian and industrial economics is essentially losing its previous significance, inasmuch

as agriculture is itself becoming industrial. Analogous processes are taking place in construction and housing and municipal services, personal services, health care, and other sectors of the national economy.

The development of large-scale mechanized production also has important socioeconomic consequences for production relations. The means of labor, the nature of labor, and accordingly the character of the worker--the skills, intellectual, and spiritual character--are changing radically.

The nature and trends of development of production are making new, more complex demands on control processes. The appearance of fundamentally new control devices is connected with the most important component of the scientific and technical revolution--automation.

Here the development of flexible automation and its highest form--flexible machine systems--has an important economic side. Medium- and small-series and custom production in machine building given their present organization and technical equipment is the least economical version of production. First, the use of general-purpose equipment requires its frequent readjustment, which decreases the output-capital ratio appreciably; second, the use of working capital worsens, which results in the growth of stocks of physical assets, the increase of unfinished production, and so on. Flexible production and flexible automation speed up the production cycle significantly and sharply reduce the stocks of physical assets, which is potentially conducive to the increase of production volumes. The acceleration of the turnover and the increase of the return of working capital are very important indicators of efficiency.

In examining the evolution of the process and forms of production automation, it is possible to distinguish three stages.

The first is individual units of automated production equipment (the beginning of the 1950's), its provision with numerical control devices (the end of the 1950's), the appearance of automated lines, a small number of computer-controlled industrial robots (the end of the 1960's), and the introduction of CNC equipment (the 1970's).

The second is automatic systems in which interconnected processes, which form integrated and computer-controlled production systems, are combined (in as optimal a manner as possible). Moreover, they began with machining centers, which carry out intraprocess transfers of objects of labor, monitoring, as well as the changing of tools (the 1980's).

The third stage is connected with the appearance of computer-aided design systems, as well as computer-controlled production and flexible machine systems. All the production functions of an enterprise (like all others) are controlled by computer and are integrated. In the opinion of the experts, such a prospect may be realized in the 1990's or at the beginning of the next century and will be based on computer technology, fifth-generation computers, artificial intelligence, laser and other measuring and test equipment, new materials, and so forth.

Progress in electronics and the rapid development of microelectronics, including microprocessors, have created a material base for realizing the most important factor of modern systems control--feedback and flexibility in production.

At the same time progress in automation has revealed "bottlenecks" of production. The logic of the development of automation requires the assurance of the continuity of the process. In the sectors with discrete technology and products two units, which upset this continuity and reduce the impact achievable by an automatic operating cycle, are clearly distinguished-- the transfer of objects of labor between subsequent operations and their manipulation during the technological process. This contradiction of large-scale mechanized production is being resolved with the appearance of means for automatic intraprocess transport and automatic industrial programmable and reprogrammable robots. The content and nature of labor also depend in many respects on their introduction.

Technology is currently becoming an increasingly active and leading component of modern production. It determines the selection of objects of labor and the means of acting on them, the methods of combining the necessary components of production in time and space; the means of optimizing the manufacture of a final product, the complete use of all useful components of raw materials and materials; the optimal interaction of the means and objects of labor. The latest achievements of science and technology, which subsequently have a radical influence on the means and objects of labor and the entire organization of production, as well as the content and nature of the labor of workers, most often are introduced in production precisely through technology.

In conjunction with the improvement of the designs of the final product (especially equipment) technology substantially simplifies and accordingly reduces the cost of the entire production process.

Improvement in technology is being observed in virtually all sectors of industry. It is resulting in an increase in quality and the appearance of new types of products and tools of labor: their power and productivity are being increased, and the operating characteristics are being improved. Better, more advanced machines and equipment are making it possible to process raw materials more efficiently, to reduce waste, and, thus, to directly influence the economy of production.

The Basic Directions of the Increase of Product Quality

In all the units of the national economy particular attention has recently been devoted to the questions of increasing the technical level, quality, and competitive ability of products, particularly machine building products.

Thus, the sectorial ministries are implementing programs of the complete standardization and metrological support of production, which are aimed at increasing the quality and reliability of the most important items. The requirements of standards are becoming more rigid. The level of work on product certification for the more objective and accurate evaluation of its quality is increasing, and the interest of enterprises in the output of

products of the highest quality is increasing. The system of the testing and acceptance of the products for production engineering, cultural, and household purposes, which is been called upon to create a barrier to the delivery to the works of obsolete and low-quality products, is being improved.

In accordance with the decree of the CPSU Central Committee and USSR Council of Ministers "On Measures on the Radical Increase of Product Quality" the following task has been posed for the organizations which are the developers of new products and new equipment: the machines, mechanisms, equipment, materials, and so, which are being newly developed, should surpass in their consumer properties the highest world achievements or correspond to them.

A special extradepartmental organ--State Product Acceptance, which is subordinate to the State Committee for Standards--has been created to prevent the output of low-quality products. At the same time a procedure, in case of which the consumer has the right to cancel at his discretion a delivery contract in case of the repeated delivery of low-quality items, has been established.

The acceleration of the pace of the implementation of the achievements of scientific and technical progress is connected with an increase of the pace of the updating of the equipment being produced. Thus, whereas previously equipment was updated every 32 years, in 1990 this time will be reduced to 7-7.5 years. The portion of production of advanced types of equipment will thereby increase significantly; the unit power, performance, reliability, and economy will be increased, and the power- and materials-output ratio of machines will be reduced. This will make it possible to radically raise the operating efficiency of all sectors of industry and to improve the quality of the output being produced, inasmuch as the latest equipment will be supplied on a large scale for the fitting out of the fuel and power and the agroindustrial complexes and for the industrialization of construction and transport, ferrous and nonferrous metallurgy, chemical and light industry, and the other sectors of the economy.

At the same time the diversity of the question, which has been and is being developed, and the discreteness of design operations in case of the designing of machines, equipment, and instruments is leading to a rapid increase in their range and an increase of type sizes, including items of identical functional purpose. This situation is causing a significant increase in labor and material expenditures, is hindering the successful organization of specialized works, is limiting the level of the mechanization and automation of production processes, and at the same time is complicating the operation and repair of equipment.

In turn, the expansion of the specialization and cooperation of production, as well as the complication of intersectorial relations are responsible for the complex nature of scientific and technical decisions in case of the designing and manufacture of a product. However, there are arising here its own problems, including the regulation of the processes of developing new equipment. Here unification and standardization as the most advanced methods of developing and producing new equipment and technology are coming to the rescue.

These methods make a radical change in the practice of planning and design work, the preparation of production, the assimilation of a product, and its use and repair.

Thus, the basic goals of unification are:

--the acceleration of the pace of scientific and technical progress by shortening the time of the development, the preparation of the production, the manufacture, and the carrying out of the maintenance and repair of items;

--the creation of the conditions for ensuring the high quality of items and the interchangeability of their component;

--the decrease of the expenditures on the designing and production of items;

--the meeting of the defense requirements of the country.

Depending on the area in which unification is carried out, it is divided into intersectorial (interdepartmental), sectorial (departmental), and plant (within an enterprise or association) unification.

Standardization with its system of preferred numbers, which makes it possible to establish optimal values of the parameters and dimensions of a product, as well as sets of standards for the basic norms, which ensure the interchangeability of parts and assemblies (units) of items, is the basis of unification.

It is well known that different organizations are involved in developing machines and equipment. This has the result that the range of machines and equipment of identical functional purpose, but different design, which are being produced, is increasing. Here the range of spare parts is growing drastically, the cost of maintaining and repairing machines and equipment is increasing, their changeover from one type size to another is becoming more difficult. Building block design--the method of designing machines and equipment from unified reusable assemblies--makes it possible to avoid these difficulties to a significant extent.

The introduction of the principles of building block design in machine building makes it possible:

--to significantly increase the level and scale of automation of production processes, having thereby ensured the increase of labor productivity and the decrease of the labor intensiveness of the production of items;

--to substantially increase the flexibility and mobility of industry during the transition to the output of new items;

--to decrease the development time and cost of automated equipment and to reduce the time and cost of the assimilation of the production of new machines, mechanisms, and instruments;

--to configure machine tools, equipment, and automated lines on the basis of ready-made assemblies.

In addition to building block design the modular principle, which makes it possible to shorten significantly the time of designing and production and to decrease the cost of many times of machine building products, is a very promising method of development new machines, equipment, apparatus, and instruments.

Unified modules in machine tool building are intended both for autonomous operation and for incorporation in systems of a higher level--a flexible readjustable line, a flexible readjustable section, and others.

Scientific and technical goal programs, which are intended for two to three five-year plans and longer, are being formulated for the rapid development of the sectors of the national economy, the more efficient solution of individual scientific and technical problems, as well as the complete use of natural resources and the improvement of product quality. The end goals and technical and economic results, the times and stages of the assimilation of operations--from scientific research to practical implementation--are stipulated in such programs. A comprehensive program of scientific and technical progress, which contains the most important directions of the development of science and technology in the USSR, has now been formulated.

In its development all-union, republic (interrepublic), and sectorial (intersectorial) scientific and technical programs of regions and territorial production complexes are being formulated and implemented. The introduction of Quality programs at enterprises, associations, sectors, and regions is having a great effect on the quality of the output being produced.

The plan of state standardization and the programs of integrated standardization, which contain comprehensive assignments on the increase of the technical and economic level and quality of items, beginning with the source raw material and ending with finished product, are playing a significant role in this matter.

The Strengthening of the Scientific and Technical Potential of the Country

The reorganization of the national economy of the country, which is presently being carried out, is posing new tasks for science, which is called upon to ensure truly revolutionary changes in the development of equipment and technology.

Such changes can be accomplished not only owing to a strengthening of the material and technical base of scientific and educational institutions and the increase of the level of research and development, but also owing to the degree of their introduction in production, by means of extensive information on the results of scientific works, discoveries, inventions, and advanced know-how of the enterprises which are introducing scientific developments.

Unfortunately, the forms of economic responsibility for introducing the results of research and development are presently poorly developed in the

production sector. The strict accounting and estimation of the cost of scientific research [NIR] with an allowance for the potential economic impact from their implementation on the maximum possible scale, as well as the introduction of a mechanism for material sanctions for unutilized scientific and technical results and the strengthening of cost accounting principles may become powerful levers of the stimulation of the more intensive use of the obtained scientific and technical solutions.

Economic levers will make it possible to increase the responsibility of production management organizations for the financing of research and development and the issuing of orders for their conducting and will make it incumbent to seek new reserves in this area. This will make it possible to reduce the number of "worthless" and inefficient jobs, will free the capacities of research and development organizations, and will expand the possibilities for the development of the competitive placement of orders for the development of new equipment.

Another means of increasing the efficiency of the work of scientific research institutions is the improvement of the organization of the management of the development of science and technology on the scale of the national economy and its sectorial and territorial units.

The improvement of the system of scientific and technical information, which could ensure the broad and effective access of users to available scientific results, is a priority tasks of the strengthening of the scientific and technical potential. In the decree of the CPSU Central Committee and USSR Council of Ministers "On Measures on the Radical Increase of Product Quality" the necessity of radically reorganizing the work of all information organizations and services is indicated.

In the USSR a rather developed system of the supply of scientific, technical, and production information to the production sector has been formed, state and sectorial information systems are being developed and introduced, and a system of the extensive exchange of advanced know-how is being developed.

In addition, analysis indicates that in order to successfully accomplish the tasks set in the area of accelerating scientific and technical progress and increasing product quality, the further development of information work should proceed in the following directions:

--the assurance of the preparation and selective dissemination of scientific and technical information based on the information requirements of workers in the national economy in accordance with specific spheres of activity;

--the strengthening of the technical base of institutes and centers of scientific and technical information with the maximum use of automated information processing;

--the uniting of all automated information systems into a unified automated network of the country.

The stimulation and correct use of the inventing activity of workers of scientific organizations, educational institutions, and production associations, enterprises, and organizations is another important aspect of strengthening the country's scientific and technical potential.

Foreign experience shows that the economic effectiveness from introducing previously planned innovations is less than the effectiveness of using the results of inventing work. This is why it is so important to use the "human factor" and important not to overlook people, who have useful ideas, are ready to work intensively for the sake of their implementation, and are capable of taking risks and obtaining an end result. In the mentioned decree of the CPSU Central Committee and USSR Council of Ministers attention is directed to the importance of conducting such work.

Steps are currently being taken to increase the level and effectiveness of sectorial science, particularly by creating powerful scientific production associations based on scientific research institutes [NII] and design bureaus [KB].

Other forms of increasing the effectiveness of sectorial science can also exist. For example, the work experience of such institutes as the Atomic Energy Institute imeni I.V. Kurchatov, the Central Aerohydrodynamic Institute imeni N.Ye. Zhukovskiy [TsAGI], the All-Union Scientific Research, Planning, and Design Institute of Metallurgical Machine Building [VNIMetmash], and a number of others has proved that the serious formation of scientific schools and correct organization of scientific activity lead to the achievement of the highest results.

One of the current tasks is the timely assimilation in production of promising design developments, advanced technological processes, and the latest materials and the extensive introduction in practice of scientific and technical achievements. For this it is necessary to unite the efforts of scientific and production collectives on the development and output of products which correspond to the world level.

The choice of the optimum indicators of the quality of products being developed with the use of the achievements of science and technology should be made at the stage of the development and designing of products. Given existing design practice it is difficult to accomplish this task, therefore, special methods of formulating and accomplishing the tasks of optimal designing by "man-machine" dialog have now been developed. It is necessary to bear in mind that it is impossible to achieve the radical restructuring of all design technology and its maximum automation at the narrow sectorial level. Intersectorial cooperation and the uniting of the efforts of all interested ministries under the supervision of a single intersectorial center are needed here.

International scientific and technical cooperation in standardization, metrology, and product quality control serves as an important means of increasing product quality and bringing the level of domestic standard technical specifications up to the world level. It is conducive, on the one

hand, to the more complete use of the international division of labor in this field, and, on the other, to the use of advanced foreign know-how.

Such international scientific and technical cooperation is being accomplished today within the framework of CEMA, the International Organization for Standardization, the International Electrotechnical Commission, the European Organization for Quality Control, International Organization for Legal Metrology, and others, as well as in the area of bilateral cooperation on standardization, metrology, and product quality control with the socialist, developing, and capitalist countries.

Questions for Self-Checking

1. What are the essence and peculiarity of the reorganization of investment and structural policy?
2. What are the most important directions of the development of scientific and technical progress?
3. What are the basic directions of the increase of product quality?
4. What are the characteristic features of modern production and how do they affect product quality?
5. What is the role of standardization and unification play in accelerating scientific and technical progress and increasing the quality of the output being produced?
6. What is the essence of the goal program approach to increasing the quality of the output being produced?
7. What are the means of strengthening the contacts of science and production?
8. What means of improving inventing, patent, and licensing work exist?
9. What are the means of increasing the level and effectiveness of sectorial and intersectorial science?
10. What is the significance of scientific and technical cooperation with foreign countries?

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PRODUCT QUALITY AS NATIONAL ECONOMIC TASK

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[Article by Candidate of Technical Sciences I.G. Leonov, deputy dean of a faculty of the All-Union Institute of Construction Materials [VISM], and I.V. Matveyeva of the editorial board of STANDARTY I KACHESTVO under the rubric "Universal Education in Quality": "Lecture 1. The Increase of Product Quality is the Most Important Task of National Economy"; capitalized passages published in boldface; first paragraph is STANDARTY I KACHESTVO introduction; first in a series of articles]

[Text] From the editorial board. With this issue of the journal we are beginning the publication of lectures in conformity with the program which was published in No 9, 1986.

In the CPSU Program, which was adopted at the 27th congress, it is emphasized that the comprehensive progress of Soviet society and its forward movement toward communism can and should be accomplished by accelerating the country's socioeconomic development. This is the strategic policy of the party, which is aimed at the qualitative transformation of all aspects of the life of Soviet society: the radical updating of its material and technical base on the basis of the achievements of the scientific and technical revolution; the improvement of social relations and, first of all, economic relations; profound changes in the content and nature of labor and in the material and spiritual conditions of people's lives; the activation of the entire system of political, social, and ideological institutions.

The task of accelerating the country's socioeconomic development, which is being posed by the party, demands profound changes first of all in the decisive sphere of human activity--economics. A sharp turn toward production intensification has to be made, and every enterprise and every sector has to be reoriented toward the complete and priority use of the qualitative factors of economic growth.

"THE TASK OF THE UTMOST INCREASE OF THE TECHNICAL LEVEL AND QUALITY OF PRODUCTS," the party Program proclaims, "IS BEING PLACED AT THE CENTER OF PARTY ECONOMIC POLICY AND ALL PRACTICAL WORK."

Speaking on 14 November of last year at the conference in the CPSU Central Committee on questions of the introduction of state product acceptance, General Secretary of the CPSU Central Committee M.S. Gorbachev said: "...the result of the work of all sectors of the economy are added together as the product. It is a question of what kind of product is sent to the national economy and determines its technical level, what also determines a person's everyday living conditions and satisfies his needs....

"The saturation of the market with items of a high technical level and high-quality consumer goods is the main feature of a full-blooded, prosperous economy. And, on the other hand, low quality and poor careless work are the most dangerous type of waste of national labor, material and technical resources, and all our national property in general."

All the facets of the problem of quality and all its aspects are outlined in the program provision:

--POLITICAL, which concerns the strengthening of the socialist system and the increase of the international authority of socialism;

--SOCIAL, which concerns the meeting of the population's needs for goods and services, as well as changes in people's social consciousness;

--ECONOMIC-SCIENTIFIC, which connected with the scientifically sound determination of society's needs for products of the necessary quality, research and development in this area, and the implementation of scientific and technical achievements;

--ECONOMIC, which is connected with the increase of production efficiency and the meeting of the country's needs with the more efficient consumption of resources;

--ORGANIZATIONAL, which concerns the questions of the improvement of the economic mechanism and the system of planning and development of the State System of Standardization.

It is difficult to separate all these aspects of the problem: they are closely interconnected and interdependent.

In his report of N.I. Ryzhkov at the 27th CPSU Congress, "On the Basic Directions of USSR Economic and Social Development for 1986-1990 and the Period to 2000," it was stated: "Among the most important problems of increasing efficiency the quality of products and work is, perhaps, the most urgent and pressing. This issue is not only economic, but also political. In a short historical time in the volumes of production of many types of products we have attained the leading positions in the world. Now we can and are obliged to solve the problem of quality with no less persistence. The national economy has reached such a point, when no important large production and social task can be accomplished without the radical improvement in the state of affairs with quality."

Let us try, on this basis, to examine the problems in accomplishing the three most important tasks posed by the Basic Directions of Economic and Social Development of the Country.

THE FIRST TASK. During the 15-year period "it is planned to raise the productivity of national labor by 2.3- to 2.5-fold. To take a decisive step in accomplishing the program task of achieving the highest world level with respect this indicator."

Can this decisive step be taken without increasing product quality? Absolutely not.

When producing items of the highest quality and more reliable, durable, and more productive machine tools and machines, production, in the words of K. Marx, shortens "the working time that is socially necessary to produce a given commodity; thus, a smaller amount of labor acquires the capability of producing a greater amount of use value."(1) Thus the well-known slogan "Better always means more as well" is realized.

The savings of national labor as a result of the improvement of quality appears at the various stages of producing, circulating, and using a product.

In PRODUCTION this is the better use of productive capital, the saving of raw materials and materials, the speeding up of the sale of products, the decrease of the number of product complaints, and the reduction of losses from defective output.

In the SPHERE OF CIRCULATION the effect of quality on social labor productivity appears in the reduction of expenditures on the sale of a product and its storage, the decrease of transportation costs, and so on.

The level of quality of many types of products, especially of the raw materials sectors, has a direct effect on the amount of transportation costs. The increase of the iron content of ore or the decrease of the ash content of coal means the reduction of the transportation of barren rock and, consequently, the saving of means of transportation worth tens of millions of rubles. The elimination or at least the reduction of returns of poor quality products can provide a substantial addition to this saving.

The effect of product quality on labor productivity appears to the greatest extent in the sphere of its USE. The use of a better product reduces the costs of consumption and decreases operating costs and repair operations. The need for equipment to perform the same amount of work decreases, the quality of the product produced by means of it improves, and working conditions and labor safety improve.

The larger the scale of production, the greater the saving of national labor. Given its current volume even a slight increase in quality yields an enormous impact.

THE SECOND TASK. "To ensure the further increase of the well-being of the people and the more and more complete meeting of the growing material and

spiritual needs of the Soviet people." It also cannot be accomplished without the preliminary solution of the problem of quality.

The improvement of the quality of items is one of the important conditions of the steady increase of the material and cultural standard of living of the people. The higher product quality is and the more completely the needs of the population are met, and the more quickly its well-being increases. The purchase of high-quality items means the more efficient use of the family budget, improves a person's mood, and stimulates him to more productive labor.

The production of high-quality items has a moral influence on the producers themselves. At enterprises, where high-quality products are produced, a feeling of pride in their enterprise emerges among the workers.

THE THIRD TASK. "To improve the structure of trade with foreign countries, first of all by increasing sales of machines, equipment, and other products of a high degree of processing." Here the answer is also clear: this task cannot be accomplished without the assurance of a high scientific and technical level and quality of products.

High-quality products have a most direct bearing on the expansion of exports. The buyers of a product judge from its quality the technical capabilities of the manufacturing country and the level of production organization. Subject to this commercial contracts for the delivery of one product or another are concluded and trade agreements are extended. The competitive ability of a product is now becoming one of the important indicators of the economic achievements of a country.

The party is devoting particular attention to THE USE OF THE INDICATOR "THE QUALITY OF OUTPUT BEING PRODUCED" IN THE EVALUATION OF THE ACTIVITY OF ENTERPRISES AND INDIVIDUAL PERFORMERS. Speaking at the conference in the CPSU Central Committee on questions of scientific and technical progress in June 1985, M.S. Gorbachev called quality the "most precise and generalizing indicator of scientific and technical progress, culture, and labor discipline."(2) In the report of the CPSU Central Committee at the 27th party congress it is stated: "It is necessary that the size of the wage fund of enterprises be directly linked to revenues from the sale of their products. This will help eliminate the production and delivery of unnecessary, low-quality items and work, as they say, for the warehouse. The same idea was heard with particular urgency at the conference in the CPSU Central Committee on questions of the introduction of state acceptance. As we see, quality as an evaluation indicator is also many-sided and can be used both as a new management lever when improving the economic mechanism and as a means of affirming the principle of social justice: whoever works better should receive more.

Thus, THE PROBLEM OF QUALITY AFFECTS EACH AND EVERYONE AND REQUIRES FOR ITS SOLUTION THE WORK OF ALL ORGANS OF MANAGEMENT OF THE NATIONAL ECONOMY AND ALL THE PARTICIPANTS IN THE PRODUCTION PROCESS.

Researchers and designers are at the source of product quality. The quality of any item depends on the quality of preliminary research and forecasts and on the level of design and industrial designer development.

Moreover, the preparation of production, the supply of quality materials and components, the development of efficient technology, the choice of the necessary equipment and tools, and the training of personnel--all these are conditions of the successful implementation of a design.

In the production stage everything contemplated by the developers should be manufactured with utmost care with the observance of all the technical and technological requirements.

Then there are circulation and sale. Products should be stored and delivered to the consumer on time and without losses.

In the stage of operation and use the observance of all the operating instruction should be ensured and maintenance and repair should be performed on time.

A mandatory stage of the work on the assurance of product quality is control and evaluation, which are carried out both during production (technical control) and at later stages (departmental and extradepartmental control of the finished product). State product certification by categories of quality, which serves as a means of quality control by means of moral and material stimuli (wholesale price markups and reductions), as well as a source of information on the actual level of product quality, is of the greatest importance.

QUALITY ASSURANCE AT ALL STAGES OF THE LIFE CYCLE OF ITEMS IS BEING FORMED INTO A SPECIFIC SYSTEM OF THE INTERACTION OF ALL THE PARTICIPANTS IN THE PRODUCTION PROCESS. The experience of the systems approach to organizing this process has found reflection in the development of comprehensive systems of product quality control.

No control system can exist without legislatively established norms and standards. The level of quality indicators, which guarantees the meeting of the needs of the national economy and population, defense of the country, and export is specified precisely in standards. Precisely standards are called upon to ensure the unity technical norms and regulations. Therefore, when speaking of product quality, we necessarily turn TO STANDARDS AND STANDARDIZATION AS ONE OF THE MAIN MEANS OF PRODUCT QUALITY CONTROL. The establishment of the necessary rigid requirements and their strict observance are a mandatory condition of the output of high-quality products. Not without reason at the June (1986) CPSU Central Committee Plenum did M.S. Gorbachev direct attention to the dependence of the situation with product quality on the state of the work on standardization in the country: "To a certain degree the formed orientation toward an average or else a low technical level of products was legitimized by the prevailing standards. The system of standards has not mobilized designers to search for new solutions and has erected an obstacle top the production of backward equipment."

On the basis of the provision of the party Program in the Basic Directions of USSR Economic and Social Development for 1986-1990 and the Period to 2000 the task was posed "to increase the share of industrial output of the highest quality category by 1.9- to 2.1-fold, to increase the reliability and service life of equipment, and to complete for the most part the introduction of comprehensive quality control systems. To speed up the revision of standards and specifications for products, orienting their toward the highest world achievements. To improve the metrological service of the national economy, to increase the level of work on the certification of industrial output so that an objective evaluation of product quality would be ensured, to develop the standardization of technologies on the basis of promising scientific and technical achievements, to intensify sectorial and intersectorial unification of machines, assemblies, and parts."

For the purpose of implementing the party policy of the radical improvement of product quality on 12 May 1986 the CPSU Central Committee and USSR Council of Ministers adopted THE DECREE "ON MEASURES ON THE RADICAL INCREASE OF PRODUCT QUALITY."

This document, which is of fundamental importance, specifies a set of organizational, economic, and legal measures aimed at increasing the technical level and quality of machines, instruments, raw material, materials, and components.

The CPSU Central Committee and USSR Council of Ministers decreed: all party, Komsomol, and trade union organs, councils of ministers of the union and autonomous republics, ministries and departments, associations, enterprises, and organizations are to regard as the most important practical task at the present stage of the country's socioeconomic development the implementation of the decisions of the 27th CPSU Congress on the radical increase of product quality in order to make a decisive turn in this important matter already during the 12th Five-Year Plan.

The increase of the quality of products and the work being performed, it is stated in the decree, should become a partywide, statewide, nationwide matter, the central link in the drafting and implementation of long-term, 5-year, and annual plans, an object of constant attention and monitoring, and the main factor in evaluating the activity of each labor collective.

The measures outlined by the decree encompass the basic stages of the life cycle of a product--from designing to use. Moreover, the decree from 12 May 1986 gives priority to the preproduction stage--research, design, development, that is, the stages when the foundations of the technical level and quality of a product are laid. Therefore, the most radical steps are aimed at THE ENHANCEMENT OF THE ROLE AND THE INCREASE OF THE RESPONSIBILITY OF DEVELOPERS.

It has been established that when developing or radically updating machines, equipment, and technological processes developers bear full responsibility for realizing the long-range demands on the technical level and quality of a product, including the service life and reliability, which correspond to or surpass the highest world achievements, while the general (chief) designers bear personal responsibility for these indicators.

For the purpose of creating the conditions for the development of high-quality products the managers of associations and organizations have been ordered to ensure the extensive introduction of computer-aided design, simulation, industrial designing, and other advanced methods of developing new models of industrial items and consumer goods, the conducting without fail of comprehensive product tests, and the development of the laboratory research and experimental design base.

Developers of the final product have been given the right to establish the requirements which are mandatory for developers of materials and components.

It is deemed necessary to establish the material and administrative responsibility of officials for the distortion of information on the achieved world level when evaluating and certifying product quality.

The ministries and departments have been charged with formulating scientific and technical goal programs on the increase of the quality and reliability of products for 1986-1990 and for the period to 2000, having envisaged in them: the forecasting of the indicators of the technical level and quality of items; the development of basic and applied research on the problems of quality and reliability; the increase of the metrological support of production; the development of test, diagnostic, and stand equipment; the increase of the demands on the organization of production, equipment and tools, means of control and measurement. It is deemed advisable to involve the branch scientific technical complexes in the formulation and implementation of these goal programs.

The attention of executives of scientific research institutes [NII] and design bureaus [KB] has been directed to the need for the more complete exercise of the rights granted to them in the establishment of bonuses for scientists, designers, and process engineers for the completion of difficult and responsible jobs, including for the development of products which have been certified as being of the highest quality category.

For the purpose of increasing the moral interest and social recognition of the authors of developments, which are of the greatest national economic impact, the decision was made to assign their names to new types of products and technological processes.

Inasmuch as any design cannot be implemented without the necessary and high-quality preparation of production, there is the following set of measures, which are outlined by the decree:

--ON THE INCREASE OF THE TECHNICAL LEVEL OF PRODUCTION AND ITS TECHNOLOGICAL EQUIPMENT.

The task to speed up substantially the assimilation in production of promising design developments and technological processes and the latest materials and the extensive introduction of scientific and technical achievements has been set for the labor collectives of associations, enterprises, and organizations.

Particular attention of executives of ministries, departments, associations, and enterprises is being directed to the extensive introduction of automated systems of the control and monitoring of technological processes, the leading development of means of the preparation of production and the capacities of shops for the production of advanced types of tools and machine tool attachments, and the priority provision of the latest types of equipment of finishing operations. It is deemed necessary to systematically hold intersectorial technological exhibitions for the sharing of know-how.

When certifying workplaces it is proposed to analyze the technological processes and the state of equipment and tools and to take the necessary steps to ensure a stable quality of the output being produced.

The need to envisage in the plans for the 12th Five-Year Plan the replacement of fixed production capital is indicated.

Particular attention in the decree is directed to measures on:

--THE INCREASE OF THE RESPONSIBILITY OF COLLECTIVES OF ASSOCIATIONS, ENTERPRISES, AND ORGANIZATIONS.

The CPSU Central Committee and USSR Council of Ministers believe that the solution of the problem of the fundamental increase of product quality is the direct responsibility of each collective, each worker, specialist, and manager. The campaign to increase product quality should become the norm of the daily life of labor collectives.

Associations, enterprises, and organizations should bear full responsibility for the quality of a product, its competitive ability on the world market, and the conformity of new items and materials to the most exacting demands, which ensure scientific and technical progress. The indicators of the technical level and quality of products should become decisive when evaluating the results of economic activity and forming the economic stimulation funds of collectives.

When establishing the level of prices for a product its technical and economic level, quality, and conformity to the best world achievements and international standard should be of decisive importance.

Personal responsibility for the output of low-quality products has been placed on the direct organizers of production--from the manager to the foreman. It has been established that the systematic output of products with deviations from the standards and specifications will be viewed as evidence of the lack of professional training of these managers for the fulfillment of their duties and their incompatibility with the held position.

The user of a product has been given the right to unilaterally cancel a contract with a supplier in cases of the repeated delivery to him of poor-quality products. Here the supplier is obliged to suspend or halt the output of the given product and to compensate the user for the harm which occurred as a result of the cancellation of the contract. The managers, through whose

fault the cancellation of the contract occurred, are to be called to account in conformity with prevailing legislation.

A quick and effective return should be given by the steps:

--ON THE REFORM OF THE SYSTEM OF TECHNICAL CONTROL AT ASSOCIATIONS AND ENTERPRISES AND ON THE FORMATION OF ORGANS OF STATE ACCEPTANCE.

The CPSU Central Committee and USSR Council of Ministers have charged the executives of ministries, departments, and enterprises to reorganize the activity of technical control services and to enhance their role in increasing product quality.

It is intended to ensure the the utmost support of technical control services in their work on identifying and preventing defective output and violations of technological discipline, to increase in labor collectives the authority of workers of the monitoring system to strengthen the technical control service with highly skilled, principled, and demanding workers, and to increase the supply of these services with advanced control and testing equipment.

Workers of the technical control services are obliged to strictly carry out their basic task on preventing the output of products which do not correspond to the standard technical specifications and to wage a resolute campaign against careless works and violators of technological discipline. In case of disturbances of technological processes or the lack of conformity of a product to the established demands the managers of the technical control services have been given the right to halt acceptance inspection and to suspend the shipment of products to consumers until steps are taken on the elimination of the shortcomings.

At all associations and enterprises it is envisaged to introduce the incoming control of arriving components, materials, and semifinished products, having assigned this duty to the technical control services. The ministries and departments, associations and enterprises, which are the suppliers of raw materials and components, have been charged with taking immediate and exhaustive measures to ensure the output of high-quality products with allowance made for the results of incoming control by consumers.

It has been deemed necessary to change the system of the remuneration of the labor and the material stimulation of workers of the technical control services, without linking it with the results of the economic activity of associations and enterprises. The quality of output being produced should become the sole criteria for evaluating the labor of the workers of these services.

For the purpose of carrying out the acceptance of finished items and the monitoring of the activity of associations enterprises on matters of quality the decision was made to establish a special organs of extradepartmental control--STATE ACCEPTANCE, having subordinate it to the USSR State Committee for Standards. As of 1 January 1987 the State Committee for Standards has been charged with introducing state acceptance at associations and

enterprises, which produce the most important national economic products, as well as consumer goods.

The party has persistently directed attention to the need to put to use first of all the human factor in accomplishing all the tasks of economic and social development. The problem of quality is also no exception. For this reason the decree "On Measures on the Radical Increase of Product Quality" envisages steps:

--ON THE IMPROVEMENT OF THE TRAINING AND ADVANCED TRAINING AND THE INCREASE OF THE SKILLS OF PERSONNEL.

Taking into account that the problem of increasing quality is complex and many-sided, it is necessary, the decree noted, for managers of all levels--from minister to foreman--to master the present demands on the development and production of high-quality products.

Ministries and departments, associations, enterprises, and organizations have been charged with to radically reorganize the system of the trading, advanced training, and increase of the skills of personnel, to carry out the systematic and continuous improvement of the skills of workers and specialists for the purpose of ensuring the conformity of their vocational training to the constantly increasing level of equipment and technology. For this it has been recommended to use extensively special-purpose courses, schools to study advanced labor techniques and methods, groups, and seminars; to introduce in practice the instruction of the workers and engineering and technical personnel, who have recently arrived at the works, in the peculiarities of technological and labor processes, to ensure their detailed familiarization with the demands, which are being made on the quality of the output being produced and the jobs being performed, especially in case of the transition to new technological processes and the assimilation of new types of products. This should be viewed as an important component of the preparation of production.

The decree demands that in 1986-1987 UNIVERSAL EDUCATION IN QUESTIONS OF QUALITY be conducted, the study of the technical, economic, and legal problems of increasing product quality be introduced into the syllabuses of higher and secondary specialized educational institutions, vocational and technical schools, as well as institutions for the increase of the skills of specialists and workers, and the necessary textbooks be prepared.

Also envisaged are steps:

--ON THE DEVELOPMENT OF THE CREATIVE INITIATIVE OF WORKERS IN THE OUTPUT OF HIGH-QUALITY PRODUCTS AND ON THE TIGHTENING UP OF EXECUTIVE DISCIPLINE.

The executives of associations and enterprises and party and trade union committees have been order to set up at associations and enterprises, in shops and sections quality groups as forms of the specific participation and active influence of all workers on the utmost increase of the quality of the output being produced and also to use more extensively the possibilities of the brigade form of the organization of labor for increasing product quality.

It has been deemed necessary that the production brigade bear collective responsibility for the output of low-quality products and compensate for harm at the expense of the brigade wage and in case of its distribution take into account the specific blame of individual workers.

It has been recommended that the collectives of brigades, which produce high-quality products and have achieved flawless work, be awarded the title "Brigade of Excellent Quality" and that they be given the right to work with a brigade stamp of quality. Increased bonuses should be credited to such collectives.

It has been deemed advisable to increase material responsibility for the harm caused to an enterprise by workers and employees in case of the production of low-quality products.

In the decree it is recommended to develop the individual and collective forms of labor competition, which have justified themselves in practice, to launch competition in accordance with the principle of "The Workers' Relay Race," to increase the role of the contests for the title "Best in the Occupation," and to stimulate the activity of brigades of the creative cooperation of workers and engineering and technical personnel on the radical increase of product quality at all stages of development and production.

In development of the decree of 12 May 1986 the USSR Council of Ministers and All-Union Central Council of Trade Unions adopted the decree "On Strengthening the Material Interest and Increasing the Responsibility of Workers of the Technical Control Services of Associations and Enterprises and Organs of the State Acceptance for Ensuring the Output of High-Quality Products."

We should dwell on the special role that the decree "On Measures on the Radical Increase of Product Quality" assigns to the STATE SYSTEM OF STANDARDIZATION and the organ that is responsible for pursuing the unified state policy in the area of quality and standardization--THE USSR STATE COMMITTEE FOR STANDARDS.

The CPSU Central Committee and USSR Council of Ministers have deemed it necessary to increase the role and responsibility of the State Committee for Standards and have obliged the committee to ensure:

--the coordination of the activity of ministries and departments, which is aimed at the achievement of stable indicators of quality and reliability and a high technical level of the output being produced;

--the active influencing of the technical level and quality of products by the systematic improvement of standards and the bringing of their requirements up to the level of international standards;

--the constant analysis of the work of associations, enterprises, and organizations on questions of increasing product quality and the taking jointly with and departments of the necessary steps on putting a stop to the

output of low-quality products by with the full exercise of the rights granted to the committee;

--the great efficiency of the activity of organs of state acceptance;

--the improvement of the state system of standardization and metrology, the increase of the effectiveness of state supervision of the introduction and observance of standards and specifications;

--extensive participation jointly with ministries and departments in the work of international organizations for standardization.

THE STATE COMMITTEE FOR STANDARDS SHOULD BECOME THE MAIN COORDINATOR OF ALL WORK ON THE INCREASE OF PRODUCT QUALITY IN THE COUNTRY.

The provisions of the decree of the CPSU Central Committee and USSR Council of Ministers, which was adopted on 12 May 1986, were embodied in decisions of the June (1986) CPSU Central Committee Plenum.

In the plan of the economic and social development of the country for the 12th Five-Year Plan, which was approved by the plenum, the task was set to see to it that in 1990 from 80 to 95 percent of the basis types of produced being produced would conform to the world level. It is necessary not only to achieve it everywhere, but also to surpass it with respect to many types of products. The accomplishment of this task, it was noted at the plenum, should be the law for machine building enterprises and design organizations, whose collectives, as advanced know-how shows, are capable of revolutionary changes in this area.

All the measures specified by the decree "On Measures on the Radical Increase of Product Quality" are an example of the comprehensive systems approach to solving the most difficult socioeconomic problem. The main thing now is their precise implementation in accordance with the spirit and letter of party policy.

One of the most radical measures stipulated by the decree--the introduction of a state product acceptance--was a discussion topic at the conference in the CPSU Central Committee of 14 November 1986.

Here the questions of the significance of product quality for the process of reorganization, for the acceleration the country's socioeconomic growth, and for the increase of its international authority were raised once again with great urgency.

In the speech of M.S. Gorbachev at this conference it was stated: "AS THE MATTER OF INCREASING QUALITY GOES IN OUR COUNTRY, SO THINGS WILL ALSO GO THROUGHOUT THE NATIONAL ECONOMY."

The most important task of the times is to be imbued with this idea and to make it a guide to action at each workplace and in each labor collective. Here the careful study and explanation of documents of the party and

government on questions of increasing product quality in all labor collectives should be regarded as a priority matter.

Questions for Self-Checking

1. What objective prerequisites dictate the necessity of increasing product quality?
2. What is the political, social, and economic significance of increasing quality?
3. Why is the increase of product quality the most important factor of the intensification of the economy?
4. What basic measures on the increase of quality are specified by the decree of the CPSU Central Committee and USSR Council of Ministers "On Measures on the Radical Increase of Product Quality?"
5. What tasks on increasing product quality were specified by the 27th CPSU Congress, the June (1986) CPSU Central Committee Plenum, and the conference in the CPSU Central Committee on question of the introduction of state product acceptance?
6. Why is an important role in increasing quality assigned to the human factor and its stimulation?
7. What measures on the radical increase of the quality of products and labor are being implemented at your enterprise, organization?

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FOOTNOTES

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